

- 4) CT of the cervical spine is performed on an intubated emergency patient who was a restrained driver in a high-speed motor vehicle collision. This reveals bilateral C2 pedicle fractures. What is the most likely underlying mechanism of injury?
- a. hyperflexion and rotation
  - b. hyperextension followed by hyperflexion *longitudinal ligament injury*
  - c. axial loading *Burst (Jefferson)*
  - d. hyperextension and traction *hangman*
  - e. hyper-rotation *soft tissue injury or facet joint dislocation*

4) d. \*\*\*

The fracture described is a hangman fracture. This involves either the pedicles or pars interarticularis of C2 bilaterally. The mechanism is usually extension and traction (as caused during hanging). Hyperflexion injuries produce anterior tear-drop or of a vertebral body wedge fractures. Axial loading can produce a burst fracture of C1 (Jefferson's fracture) or a vertebral body elsewhere in the spine. Hyperflexion and extension are associated with longitudinal ligament injury. Hyper-rotation is associated with soft-tissue injury or facet joint dislocation.

- 7) A child passenger is admitted to accident and emergency following a road traffic collision. Radiographs of the spine show a horizontal fracture involving the vertebral body and pedicles of L2. Associated injury to which of the following abdominal organs is most likely?
- a. duodenum
  - b. pancreas
  - c. spleen
  - d. liver
  - e. rectum

7) a. \*\*\*

The spinal injury described is a **Chance fracture**, a fracture through the vertebral body and pedicles caused by **hyperflexion**, therefore causing compression of the spine anteriorly and distraction posteriorly. This injury typically occurs in back-seat passengers wearing a lap seat belt during a road traffic collision. In children, there is a **50% incidence of associated intra-abdominal organ injury**. **Retroperitoneal organs** are most vulnerable, being closest to the spine. **Duodenal injuries** are most common, and have a significant associated mortality. **The pancreas** is also commonly injured due to its retroperitoneal location.

10) A 28-year-old physically active young man undergoes a hip MR arthrogram for chronic pain that is worse during exercise. There is a history of several months of hip pain when the patient was a teenager that was not investigated. Images show a loss of the femoroacetabular sulcus superiorly with an associated acetabular labral tear. What is the underlying condition?

- a. pincer femoroacetabular impingement
- b. cam femoroacetabular impingement
- c. combined femoroacetabular impingement
- d. traumatic labral tear
- e. osteochondritis dissecans

10) b. \*\*\*\*

**Cam** is the most common form of femoroacetabular impingement in men, typically presenting in the **third or fourth decade**. It is often related to a previous slipped upper femoral epiphysis in the teenage years. A change in the rotational axis (increase in the alpha angle) causes the



proximal superior femoral neck to impinge upon the superior acetabular margin and labrum, in turn causing intermittent pain, particularly in physically active individuals. Even without a history of slipped femoral epiphysis, an osseous bump on the superior femoral neck obliterating the femoroacetabular sulcus can cause symptoms. Labral or articular cartilaginous tears can follow repetitive microtrauma, leading to persistent pain and locking. The pincer type is more common in women and is caused by an abnormally deep acetabulum.

11) You receive a referral while on call from the orthopaedic consultant regarding a middle-aged woman with a long history of simple back pain. She has attended accident and emergency complaining of worsening lower lumbar pain with a several-hour history of progressive urinary retention, faecal incontinence, saddle anaesthesia and mild bilateral leg weakness. Which method of imaging would you recommend as most appropriate?

- a. plain radiography
  - b. myelogram
  - c. CT
  - d. CT myelogram
  - ☒ e. MRI
- cauda equina is an orthopaedic emergency and delay may cause permanent injury.*

11) e. \*\*

Bilateral lower limb involvement suggests a myelopathy rather than a radiculopathy. The presence of urinary and bowel symptoms and saddle anaesthesia suggests compression of lumbosacral nerve roots. This complex of symptoms is cauda equina syndrome and is considered an orthopaedic emergency because of the likelihood of permanent neurological impairment, particularly affecting the autonomic supply to the bladder or bowel, which can result in permanent incontinence if surgery is delayed. The Royal College of Radiologists recommends proceeding straight to MRI in patients who have 'red flag' signs.

18) In a patient who presents with acute femoral nerve radiculopathy, which of the following MRI sequences is the most useful in the diagnosis of a far lateral upper lumbar vertebral disc protrusion?

- a. sagittal STIR
- b. sagittal T1
- c. sagittal T2
- d. axial STIR
- e. axial T2

18) e. \*\*\*\*

The far lateral disc protrusion is the least common type of symptomatic disc herniation. It distinguishes itself from the posterolateral herniation in that the disc ruptures outside the spinal canal, lateral to the root foramen. The disc, instead of tethering the traversing nerve root, compresses the more rostral nerve root that has already exited the root foramen. The neurological symptoms therefore correspond to a lesion at the upper disc level, often leading to confusion in the diagnosis. It is also difficult to diagnose radiologically, as the far lateral location is usually not detected on the sagittal images but only on axial images. STIR is an inversion recovery sequence that suppresses fat and so highlights areas of increased fluid. However, it is not sensitive when the herniation is outside the fluid-filled spinal canal; therefore, the T2V gradient echo sequence is better at detecting far lateral disc herniation.

26) On plain radiographs of the neck in a 60-year-old man, which feature is most likely to support a diagnosis of diffuse idiopathic skeletal hyperostosis rather than ankylosing spondylitis?

- a. enthesopathy
- b. confluent intervertebral bony bridging
- c. sparing of the posterior elements
- d. sparing of the sacroiliac joints
- e. changes limited to the thoracic spine

26) d. \*\*\*

Diffuse idiopathic skeletal hyperostosis (DISH) is an ankylosing disorder of the spine. It is most commonly seen in the thoracic region but may involve cervical and lumbar regions. Diagnostic criteria are of flowing calcification along the anterolateral border of at least four vertebral bodies, relative preservation of intervertebral disc height, and absence of sacroiliac joint or apophyseal involvement. These three criteria aid differentiation of spondylosis deformans, intervertebral osteochondromatosis and ankylosing spondylitis respectively.

Extra-spinal manifestations of DISH include Achilles tendinosis, tennis elbow, calcaneal and olecranon enthesopathy and dysphagia. Whiskering is seen radiographically at tendinous insertions, particularly of the pelvis.

27) A lumbar spinal MRI is performed on a young man of south-east Asian origin for back pain and pyrexia of unknown origin. It reveals an anterior paraspinal soft-tissue mass at levels L1 to L3 centred at the L2-3 intervertebral disc. It is located deep to and displaces the anterior longitudinal ligament, and extends into the left psoas muscle. The mass returns intermediate signal on T1W images and high signal on T2W images. There are oedematous changes in the adjacent vertebral bodies, but the intervertebral discs are spared. What is the most likely infectious organism?

- a. *Mycobacterium tuberculosis*
- b. *Actinomyces*
- c. HIV
- d. *Staphylococcus aureus*
- e. *Aspergillus fumigatus*



27) a. \*\*

The musculoskeletal system is affected in only 1–3% of tuberculous infections, but the spine is the most common skeletal location affected, accounting for 50% of musculoskeletal tuberculosis. Tuberculous spondylitis (or Pott's disease) can result in significant neurological sequelae. A history of pulmonary infection may or may not be present. The infection usually begins in the anterior vertebral body via haematogenous spread. The intervertebral discs are frequently involved, and the loose internal structure of the disc allows the infection to disseminate more widely, often resulting in paraspinal or psoas abscess. **Calcification within the abscess is very specific for tuberculosis.** The disease process often leads to vertebral collapse with gibbous deformity and obliteration of the disc space. However, elevation of the anterior ligaments by subligamentous abscess allows tracking superiorly and inferiorly, and classically spares the disc. Tuberculosis characteristically results in little reactive sclerosis or periosteal reaction, which helps to distinguish it from pyogenic infections.

29) On lateral radiographs of the thoracolumbar spine, a central anterior beak of the vertebral bodies is most likely to suggest which of the following conditions?

- a. Scheuermann's disease *no beak*
- b. Morquio's syndrome
- c. Hurler's syndrome *inferior beak*
- d. Down's syndrome *inferior beak*
- e. achondroplasia *inferior beak*

29) b. \*\*\*

Morquio's syndrome is type IV and the most common of the mucopolysaccharidoses, a family of inherited disorders of metabolism. A central vertebral beak is relatively specific for the condition. Other spinal manifestations include odontoid hypoplasia with atlantoaxial subluxation (which can be life threatening), platyspondyly, ovoid vertebral bodies, widened intervertebral disc space and exaggeration of the normal lumbar lordosis. Other skeletal findings include dwarfism, as well as skull, face and appendicular abnormalities. Hurler's syndrome belongs to the same family of disorders but has an inferior vertebral

beak, which is also seen in achondroplasia and Down's syndrome. Scheuermann's disease does not show vertebral beaking.

31) Plain radiographs of the spine in a 40-year-old man performed following a road traffic collision reveal a slightly expanded midthoracic vertebral body with coarse vertical trabeculations. Subsequent CT shows a 'polka-dot' appearance to the same vertebral body in the axial plane. What is the most likely disorder affecting the vertebra?

- a. aneurysmal bone cyst
- b. osteoid osteoma
- c. haemangioma
- d. compression fracture
- e. osteopoikilosis

31) c. \*

Metastatic disease, myeloma and lymphoma are the most common malignant spinal tumours, and haemangioma is the most common benign tumour of the spine. The appearances described are characteristic of a vertebral haemangioma. On MRI, these lesions typically appear of mottled low-to-high signal on T1W images depending on the degree of fat present, and of very high signal on T2W images. Other primary osseous lesions of the spine are more unusual but may exhibit characteristic imaging features that can help develop a differential diagnosis. Radiological evaluation of a patient who presents with osseous vertebral lesions often includes radiography, CT and MRI. The complex anatomy of the vertebrae means that CT is more useful than conventional radiography for evaluating lesion location and assessing bone destruction. The diagnosis of spinal tumours is based on patient age, topographic features of the tumour and lesion pattern as seen on imaging.

36) A 40-year-old man falls down the stairs and remains unconscious for several hours. On admission to hospital, he is found to have bilateral upper limb weakness, patchy sensory loss, full power in the lower limbs and a normal level of consciousness. Plain radiographs of the cervical spine and CT of the brain are normal. On MRI of the cervical spine, there is a small area of oedema identified within the cord. Clinical symptoms persist for 4 days following injury. What is the most likely diagnosis?

- a. central cord syndrome
- b. anterior cord syndrome
- c. SCIWORA (spinal cord injury without radiological abnormality)
- d. spinal shock
- e. Brown-Séquard syndrome



36) a: \*\*\*\*

In trauma, an incomplete spinal cord injury is one in which there is any degree of sparing of motor or sensory function distal to the site of injury, whereas complete cord injury results in complete lack of neurological function distal to the injury. The diagnosis can be made only in the absence of spinal shock, a transient spinal cord concussion.

Central cord syndrome is the most common incomplete injury, and is associated with hyperextension injury in middle-aged patients; injury to centrally located grey matter in the cord causes a greater motor neurological deficit in the upper than in the lower extremities. Sensory involvement can be variable, and bowel and bladder function may be affected. Anterior cord syndrome, caused by anterior spinal vascular insufficiency, causes complete motor paralysis with sparing of the posterior columns. SCIWORA is seen in children, when the elastic cervical spine deforms sufficiently to cause cord injury but without any radiological findings. Brown-Séquard syndrome results from hemitransection and causes ipsilateral muscle paralysis and contralateral hyperaesthesia to pain and temperature.

37) Vertebral sclerosis confined to the upper and lower endplates with preservation of the intervertebral disc space ('rugger jersey spine'), is seen most commonly with which underlying condition?

- a. osteoporosis
- b. discitis *causes reduction of intervertebral disc space with indistinct end plates*
- c. mucopolysaccharidosis *cause bending rather than sclerosis*
- d. Paget's disease
- e. renal osteodystrophy *ie secondary hyperparathyroidism*

37) e. \*\*\*

The 'rugger jersey spine' appearance refers to sclerotic bands along the superior and inferior endplates of the thoracic and lumbar vertebral bodies. These bands represent accumulation of excess osteoid and result in a striped appearance of the vertebral bodies. Despite being poorly mineralized, the accumulated osteoid appears opaque on plain radiographs because of its increased volume compared with that of normal bone. The 'rugger jersey spine' is said to be almost pathognomonic for the osteosclerosis seen with the secondary hyperparathyroidism of chronic renal failure. Renal osteodystrophy is a term for the constellation of musculoskeletal abnormalities occurring with chronic renal failure. Osteoporosis and Paget's disease are more likely to affect the whole of the vertebrae diffusely. Discitis usually causes a reduction in the intervertebral disc space on radiographs, with indistinct endplates. The mucopolysaccharidoses result in anterior vertebral body beaking rather than sclerosis.

43) A middle-aged male patient who has previously undergone partial discectomy for radiculopathy, has a lumbar spine MRI due to a recurrence of his symptoms. T1W images show a low-signal area of tissue contiguous with the previously operated intervertebral disc and impinging upon the adjacent exiting nerve root. Which single additional finding favours a diagnosis of postoperative fibrosis over recurrent disc protrusion?

- a. high signal on STIR sequence
- b. enhancement with intravenous gadolinium
- c. evolution at 6-month serial imaging
- d. oedema in the surrounding bone
- e. low signal on T2W images

43) b. \*\*

In MRI of the spine in postoperative discectomy patients with recurrent or persistent radiculopathy, a T1W sequence with intravenous gadolinium enhancement is added to distinguish between postoperative epidural fibrosis (or scarring) and recurrent disc herniation. Both can have similar, low-signal appearances on unenhanced T1W and T2W images, but fibrosis will show enhancement with gadolinium whereas recurrent disc prolapse will not. Difficulties arise where both conditions exist concurrently, and fibrosis that is not causing nerve root irritation may also enhance. The importance of distinguishing between the two is that surgical treatment is indicated for recurrent disc herniation but is of no value in treating postoperative fibrosis, also known as failed back syndrome.

47) The Catterall 'head at risk' signs are plain radiographic signs that indicate a poor prognosis and increased risk of femoral head collapse in Legg-Calvé-Perthes disease. Which of the following options is not such a sign?

- a. Gage's sign (wedge-shaped lysis of the femoral head)
- b. calcification lateral to the epiphysis
- c. lateral subluxation of the epiphysis
- d. metaphyseal bone resorption
- e. horizontal orientation of the growth plate



47) d. \*\*\*\*\*

Catterall described four radiographic signs that indicate a femoral 'head at risk' of avascular necrosis (Perthes' disease), in an attempt to predict those cases in which considerable collapse of the femoral head may occur. Gage's sign is a radiolucent V-shape seen in the lateral side of the epiphysis on frontal pelvis radiographs. Calcification lateral to the epiphysis indicates a small area of lateral head collapse. The third sign is lateral subluxation, best seen as an increased inferomedial joint space, which when seen in conjunction with the first two worsens the prognosis. Finally, in some individuals the normal growth plate is more horizontally orientated, which results in normal weight-bearing forces exerting a shearing force on the growth plate, rather than a compressive force as seen in the more common transversely orientated growth plate. A horizontal growth plate is therefore considered a further poor prognostic sign in Perthes' disease.

52) A young adult male sustains an acetabular fracture in a high-speed road traffic collision. Which type of acetabular fracture is most commonly associated with significant neurological injury?

- a. posterior rim/wall
- b. anterior rim/wall
- c. transverse T-shape
- d. anterior and posterior column
- e. central dislocation

52) a. \*\*

Acetabular fractures are common in multiple or major trauma patients, particularly those involved in road traffic collisions, and are classified according to the Letournel classification. Fractures are often complex and require accurate delineation with CT, often following limited or suboptimal initial radiographic investigation with or without oblique pelvic (Judet) views. Isolated posterior rim or wall fractures are the most common type (27%) and are associated with a high frequency of posterior dislocation of the femoral head causing sciatic nerve injury. If the entire posterior column is involved in the fracture, there is a lower incidence of sciatic nerve injury, as the femoral head may not be dislocated. Anterior injuries are uncommon (5%) and may be associated with anterior femoral head dislocation and iliac wing fracture. Transverse fractures account for 9%.

63) An elderly woman falls down the stairs and suffers a Malgaigne fracture of the pelvis and a 1% degloving injury to the left forearm. Due to significant medical co-morbidity, the decision is made not to treat with surgery. The patient dies overnight on the ward. What is the most likely mechanism of death?

- a. pulmonary embolism
- b. fat embolism
- c. septicaemia
- d. myocardial infarction
- e. intra-abdominal haemorrhage

63) e. \*\*

A Malgaigne fracture of the pelvis is a fracture of the ischiopubic rami and an ipsilateral sacroiliac joint (or para-articular) fracture, and occurs due to high-energy blunt trauma. It represents complete disruption of the pelvic ring and therefore an unstable fracture. In such fractures, distortion and disruption of the pelvic soft tissues and vascular injury involving the rich blood supply in the pelvis will not be tamponaded by the bony ring, as the pelvis will expand to accommodate ever-increasing haematoma. Mortality rate from major pelvic trauma is 10%; other common causes of death include multiorgan failure and sepsis, the latter expected to take several days to evolve.

64) A 20-year-old man is a restrained driver in a high-speed road traffic collision. On admission to accident and emergency he undergoes CT of the brain for a reduced consciousness level. Images show diffuse brain injury. Which of the following findings would support a diagnosis of diffuse axonal injury rather than simple contusions?

- a. corticomedullary petechial haematoma
- b. anterior temporal petechial haematoma
- c. basofrontal petechial haematoma
- d. intraventricular haemorrhage
- e. brain oedema



64) a. \*\*

**Contusions** are traumatic injuries to the cortical grey matter of the brain and make up approximately half of primary intra-axial traumatic lesions. They are often multiple and bilateral, with the most common locations being the inferior frontal lobes and temporal poles. **Diffuse axonal injury** results from rotational shearing forces on cerebral white matter and common locations are white matter-rich areas, such as the corticomedullary junction, centrum semiovale, corpus callosum and cerebellum. In comparison to diffuse axonal injury, contusions tend to be larger and more superficial, with a higher proportion being haemorrhagic due to the increased vascularity of grey compared with white matter. Local or widespread oedema can be seen in both conditions.

67) In reviewing a fracture of the spine at the thoracolumbar junction in a major trauma case, which single indicator on CT is most sensitive for inferring instability?

- a. widened facet joints
- b. two-column malalignment
- c. soft-tissue swelling
- d. rotational abnormality
- e. increased intervertebral disc space

67) b. \*\*

The spine can be divided anatomically into three columns: the anterior column contains the anterior longitudinal ligament, anterior half of the vertebral body and anterior annulus fibrosus; the middle column contains the posterior half of the vertebral body, posterior longitudinal ligament and the posterior annulus fibrosus; and the posterior column contains the posterior elements of the spine, facet joint capsule and interspinous ligaments. Two intact columns are required for intrinsic spinal stability. Disruption of two columns can therefore be used to infer instability. Usual traumatic patterns are anterior and middle, or posterior and middle, disruption. Isolated middle column interruption can occur after trauma or surgery, or as a congenital abnormality, and is also considered potentially unstable.

- 76) A 50-year-old mechanic with a long history of back pain presents to the spinal clinic complaining of sudden onset of numbness and pain over the right lateral calf and dorsum and sole of the right foot following heavy lifting. Which of the following spinal pathologies is most likely to explain the patient's symptoms?
- a. lumbar spinal stenosis
  - b. paracentral L4–5 disc protrusion
  - c. paracentral L5–S1 disc protrusion
  - d. far lateral L4–5 disc protrusion
  - e. central L5–S1 disc protrusion

76) b. \*\*\*\*

Degenerative disc disease of the spine is one of the leading causes of functional incapacity and chronic disability in the working population, affecting both men and women. Although there is no universally established nomenclature for describing disc herniation, 'protrusion' is commonly used if the herniation is broader than it is deep and 'extrusion' if it is deeper than it is broad. A disc 'bulge' is used to describe a herniation that is very broad based and may even be circumferential, with a generalised disc bulge being one that affects at least half of the periphery. As a result of the strong posterior longitudinal ligament, posterior disc herniation is often paracentral, i.e. to the side of the midline. This can result in compression of the transiting nerve root in the lateral recess, which is the one that will exit at the level below. A lateral disc herniation narrowing the neural foramen compresses the exiting nerve root. Therefore, for a given intervertebral disc, a paracentral herniation will affect the nerve that exits one level below, whereas a lateral protrusion affects the nerve root at that level.

81) Which of the following is not an appropriate indication for percutaneous polymethylmethacrylate cement vertebroplasty?

- a. progressive osteoporotic deformity
- b. painful osteoporotic collapse
- c. painful haemangioma
- d. painful osteoid osteoma
- e. painful metastases

81) d. \*\*\*\*

Percutaneous cement vertebroplasty is a treatment for vertebral compression fractures that involves the injection of acrylic bone cement into the vertebral body in order to relieve pain, stabilize fractured vertebrae or, in some cases, restore vertebral height. Current guidelines from the National Institute for Health and Clinical Excellence (NICE), regarding the use of vertebroplasty in the UK, state that it may be used for pain relief in patients with severe painful osteoporosis with loss of height, compression fractures of the vertebral body, symptomatic vertebral haemangioma and painful vertebral body tumours (metastases or myeloma). Review of current evidence indicates some level of pain relief in 58–97% of patients.

82) On MRI of the spine demonstrating vertebral body collapse, which additional feature favours an underlying diagnosis of malignancy rather than osteoporosis?

- a. bone fragment retropulsion
- b. focal low signal in the vertebral body on T1W images
- c. diffuse intermediate signal in the vertebral body on T2W images
- d. no enhancement with gadolinium
- e. convex posterior border to the vertebral body



82) e. \*\*\*

A convex bulge involving the whole posterior border of the vertebral body strongly suggests vertebral body expansion by tumour invasion, and is only very rarely a feature of osteoporosis. Other findings on MRI suggestive of malignancy include a soft-tissue mass, involvement of the pedicles, and heterogeneous high signal on T1W post-contrast or T2W images. Retropulsion of bone fragments, focal T1 low signal or an isointense appearance on T1W or T2W images suggests osteoporotic collapse.

84) A 35-year-old woman of African origin is admitted to accident and emergency with acute abdominal and back pain with pyrexia. Radiographs of the chest, abdomen and lumbar spine show rib thinning with notching, sclerosis of the right humeral head and biconcave, 'fish-shaped', lumbar vertebral bodies. A subsequent radiograph of the skull reveals widening of the diploë with hair-on-end striations. What is the most likely underlying condition?

- a. neurofibromatosis
- b. thalassaemia major
- c. sickle cell disease
- d. syphilis
- e. Scheuermann's disease

84) c. \*\*

Sickle cell disease is a haemoglobinopathy that results from the presence of abnormal  $\beta$ -globin chains within haemoglobin, which may manifest as anaemia, infarction and superimposed infection. It is much more prevalent in those of African-Caribbean origin. Over time, the disease produces musculoskeletal abnormalities as a result of chronic anaemia, such as marrow proliferation (which produces the characteristic changes in the skull), marrow reconversion and extramedullary haematopoiesis. Other common skeletal complications include bone softening, infection or infarction.

88) On radiographs and MRI of the spine performed for lower back pain with clinical signs of radiculopathy, which of the following features favours a diagnosis of discitis rather than degenerative disc disease?

- a. vacuum phenomenon in the discs
- b. reduced disc space
- ☒ c. intermediate signal posterior to the vertebral body on T1W images
- d. vertebral endplate low signal on T1W images
- e. Schmorl's nodes

88) c. \*\*

Intermediate signal in the extradural space on T1W images is the most common appearance of extradural abscess formation. The most common primary focus of infection is discitis, but abscess formation may also be spontaneous. Patients particularly at risk are those with a history of diabetes mellitus, intravenous drug use, trauma, haemodialysis or recent surgery (particularly dental). MRI features of extradural abscess include iso- or slight hyperintensity on T1W images when compared with the spinal cord. High signal on T2W and proton density sequences makes it difficult to differentiate abscess from CSF, but these sequences are useful, as osteomyelitis and paravertebral abscess are well visualized as high-signal lesions. Administration of intravenous gadolinium contrast characteristically demonstrates diffuse enhancement of the solid component of the abscess.

92) Vertebral bone marrow oedema, seen as low signal on T1W and high signal on T2W MR images, occurs typically in all but which of the following conditions?

- a. degenerative disc disease
- ☒ b. multiple myeloma
- c. osteoporotic collapse
- d. spondylolysis
- e. ankylosing spondylitis

92) b. \*\*

Multiple myeloma is a malignant condition of plasma cells that commonly shows infiltration of the bone marrow, best seen on MRI. Patterns of infiltration can be classified as focal, diffuse or variegated. Although marrow infiltration returns similar signal to marrow oedema on T1W and T2W images, infiltration will show diffuse enhancement following administration of intravenous gadolinium. The pattern of infiltration also differs. Infiltration will be patchy and randomly distributed throughout the vertebral bone. In contrast, bone oedema occurs adjacent to its cause, being linear at the endplates in the case of degenerative disc disease, and linear with a fracture line in osteoporotic collapse, in the pedicles adjacent to spondylolysis or at the entheses in ankylosing spondylitis.

96) A 30-year-old woman in the third trimester of pregnancy complains of a 4-week history of gradual onset of pain in the left hip following minor trauma. Radiographs show a normal-appearing joint space, mild osteopenia of the femoral head and neck, and an indistinct subchondral femoral head. On subsequent MRI, the bone marrow in the affected regions returns patchy but diffuse low signal on T1W and high signal on T2W images. There is a similar small area of marrow abnormality in the acetabulum, and a small hip effusion is seen. What is the most likely diagnosis?

- a. septic arthritis
- b. infarction
- c. reflex sympathetic dystrophy
- d. rheumatoid arthritis
- e. transient osteoporosis



96) e. \*\*\*\*

Transient osteoporosis of the hip is part of the bone marrow oedema syndromes that also encompass migratory regional osteoporosis and transient bone marrow oedema. The condition is spontaneous and self-limiting, clinical recovery occurring in several weeks to months with no specific treatment, although radiographic changes lag behind. It is seen in pregnant women in the third trimester and middle-aged men. The radiographic hallmark is the loss of subchondral cortex in the femoral head, and marrow oedema is seen on MRI with intense uptake of  $^{99m}\text{Tc}$ -labelled diphosphonates on bone scintigraphy. The aetiology is uncertain, but speculation has been made that the bone marrow oedema syndromes are related to reflex sympathetic dystrophy. The appearance of transient osteoporosis of the hip may be mimicked by osteonecrosis.

3. A 56 year old motorcyclist has a trauma series of plain films following a road traffic accident. On evaluation of the lateral cervical spine film, which of the following soft-tissue parameters would be a concerning feature?
- Predental space of 3 mm
  - Nasopharyngeal space of 7 mm
  - Retropharyngeal space of 10 mm
  - Retrotracheal space of 20 mm
  - Decreased disc space at the C5/6 level

3. c. Retropharyngeal space of 10 mm

This is too wide for the retropharyngeal space. The correct acceptable limits for soft-tissue measurements are as follows:

- Predental space 3 mm in adults, 5 mm in children.
- Nasopharyngeal space (anterior to C1) 10 mm.
- Retropharyngeal space (C2–C4) 5–7 mm.
- Retrotracheal space (C5–C7) 22 mm.

Disc spaces should be roughly equal throughout the cervical spine. Narrowing of a disc space is usually due to degenerative change, but widening would be a more concerning feature.

13. A middle-aged woman undergoes an MRI of the lumbar spine for longstanding lower back pain. She has no specific neurological signs and is otherwise well. MRI shows some lower lumbar spine facet joint arthropathy and a 2×2 cm well-defined rounded lesion in the L3 vertebral body. This displays high signal on both the T1 and T2 sequences. The most likely explanation for this lesion is:
- Discitis
  - Lymphoma
  - Myeloma
  - Metastatic deposit
  - Haemangioma

13. e. Haemangioma

This is most likely to be a benign haemangioma. These are relatively common lesions seen as incidental findings on spinal imaging. High signal on T1 imaging is indicative of the presence of fat within the lesion. All the other conditions would give a low-signal lesion on T1 imaging.

14. A 21 year old long-distance runner complains of increasing right groin pain. Plain films show no acute bony injury, but demonstrate a pistol grip deformity of the femoral head, an osseous bump deforming the femoral head-neck junction and an alpha angle of 70°. The acetabulum appears normal. The most likely diagnosis is:
- Hip dysplasia
  - Pincer-type acetabular impingement
  - Cam-type acetabular impingement
  - Sportsman's hernia
  - Avascular necrosis

14. c. Cam-type acetabular impingement

Femoroacetabular impingement (FAI) occurs as a result of repetitive microtrauma due to an anatomic conflict between the proximal femur and the acetabular rim at the extremes of motion. An osseous bump at the femoral head-neck junction is present in 50% of cam-type FAI and only 33% of pincer-type FAI. An alpha angle of >55° is indicative of cam-type FAI. The alpha angle, drawn on the AP pelvis radiograph, is formed by a line drawn from the centre of the femoral head through the centre of the femoral neck, and a line from the centre of the femoral head to the femoral head-neck junction, found by the point by which the femoral neck diverges from a circle drawn around the femoral head. A normal patient's alpha angle is around 45°, whereas for patients with FAI it may be around 70°.

17. A 74 year old woman presents with back pain and no history of recent trauma. Lateral plain radiographs show partial collapse of the L2 vertebral body. Which of the following findings would be more suggestive of osteoporotic collapse than malignancy?
- a. Complete replacement of the normal marrow signal within the vertebral body on T1 imaging
  - b. Bilateral pedicular involvement with expansion of the right pedicle
  - c. Bulging and convex appearance to the vertebral body
  - d. Nodular irregular epidural mass
  - e. Intervertebral vacuum phenomenon

**17. e. Intervertebral vacuum phenomenon**

Intervertebral vacuum phenomenon is highly specific for osteoporotic collapse, although it is not common. The other features are all more suggestive of malignancy than osteoporotic collapse. Pedicular destruction occurs in 50% of cases of malignant collapse but in less than 1% of osteoporotic collapse.

18. A 23 year old man sustains a Jefferson fracture to his cervical spine following an injury in which he dived into a shallow swimming pool, hitting his head on the bottom. Which of the following regarding his injury is incorrect?
- a. Displacement of the lateral masses of C1 relative to the dens on an odontoid view indicates a transverse ligament rupture
  - b. Associated C2 fracture will be present in up to 30% of cases
  - c. Jefferson fractures are usually associated with a neurological deficit
  - d. Up to 50% are associated with a further cervical spine injury
  - e. There may be associated vertebral artery injury

**18. c. Jefferson fractures are usually associated with a neurological deficit**

Jefferson fractures are not usually associated with neurological deficit. Although there may be retropulsion of fragments into the vertebral canal, spinal cord injury is rare due to the large dimensions of the canal at this level. Vertebral artery injury, however, must be considered and if there is concern either CTA or MRA imaging should be considered.

27. A 52 year old woman presents to her GP with a longstanding history of lower back pain which has suddenly worsened in severity over the past few days. An urgent MRI scan of the lumbar spine shows a right paracentral disc protrusion at the L4/L5 level. The disc impinges on the lateral recess at this level. The most likely nerve to be affected is the:
- a. Cauda equina
  - b. Lumbar plexus
  - c. Right L4
  - d. Right L5
  - e. Right S1

27. **d. Right L5**

The right L5 nerve root is the most likely to be affected as it will be sitting in the right lateral recess at the L4/5 level. The L4 nerve root will be at the exit foramen and therefore if the protrusion affects only the lateral recess then this nerve will already have exited and therefore not be affected.

29. A 70 year old male presents with increasing pain in his right hip over the past month. There is no specific history of trauma. A plain radiograph demonstrates the presence of an incomplete fracture of the femoral neck arising from the lateral (convex) side. What is the most likely underlying abnormality of the femoral neck?
- a. Osteomalacia
  - b. Metastasis
  - c. Osteoid osteoma
  - d. Infection
  - e. Paget's disease

29. **e. Paget's disease**

Incremental fractures (banana fracture) along the convex side of the bone are classically associated with Paget's disease. These most commonly occur in the femur where they cause lateral bowing, and the tibia where they cause anterior bowing. Compression fractures of the vertebrae are also associated with Paget's.



31. A 17 year old patient complains of lower thoracic back pain. Plain radiographs of the thoraco-lumbar spine show wedging of multiple vertebrae at the thoraco-lumbar junction, multiple limbus vertebrae, an increase in the AP diameter with a reduction in the sagittal height of multiple vertebrae, and multiple endplate defects. What is the unifying diagnosis?
- a. Scheuermann's disease
  - b. Ankylosing spondylitis
  - c. *Mycobacterium tuberculosis*
  - d. Hyperparathyroidism
  - e. DISH

**31. a. Scheuermann's disease**

These are the classical appearances of Scheuermann's disease. This condition usually presents at puberty and consists of vertebral wedging, endplate irregularity and narrowing of the intervertebral disc spaces. The most common location is in the lower thoracic and upper lumbar spine. Schmorl's nodes are often present.

32. A 70 year old patient complains of back pain and leg pain after walking 50 metres. Plain radiographs show an anterior slip of L4 relative to L5. The spinous process of L4 is also noted to have moved anterior to the L5 spinous process. What type of spondylolisthesis does this represent?
- a. Traumatic
  - b. Degenerative
  - c. Spondylolytic
  - d. Dysplastic
  - e. Pathological

**32. b. Degenerative**

This is the classical description of the symptoms and radiology of a degenerative spondylolisthesis. Degenerative spondylolisthesis is usually symptomatic due to spinal stenosis and narrowing of neural foramen. This most commonly occurs at the L4/5 level. Spondylolysis is a defect in the pars interarticularis between superior and inferior articulating processes.

33. A 56 year old male is admitted under the orthopaedic team with increasingly severe lower back pain which started three weeks ago. MRI demonstrates an oedematous L4/5 intervertebral disc, marked loss of disc material and oedematous adjacent endplate changes. There is associated paravertebral inflammatory tissue and a small amount of pus within the residual disc space. The findings are consistent with infective discitis. What is the most likely causative organism?
- a. *Mycobacterium tuberculosis*
  - b. *Streptococcus pyogenes*
  - c. *Staphylococcus aureus*
  - d. *Escherichia coli*
  - e. *Salmonella*

33. **c. *Staphylococcus aureus***

The most common cause of infective discitis is *Staphylococcus aureus*, which gives the above typical findings. The only other relatively common cause is *Mycobacterium tuberculosis*, which typically spares the disc until late and usually has a large amount of associated pus.

34. A 25 year old male is involved in a 60 mph road traffic accident with a head-on collision. He was wearing a seat-belt but his car did not have an air-bag. A screening lateral radiograph of the cervical spine shows the following findings: an angular kyphosis centred at C4/C5, a 1 mm anterior slip of C4 on C5, and widening of the interspinous space posteriorly. What is the likely mechanism for this injury?
- a. Lateral compression
  - b. Flexion
  - c. Extension
  - d. Combination
  - e. Rotation

34. **b. Flexion**

This describes the typical appearance for a flexion injury as well as the typical mechanism. This would represent a potentially unstable fracture and immobilisation would be essential until further management decisions are made. Flexion teardrop injuries are more common in the lower cervical spine and extension teardrop injuries are more common in the upper cervical spine.

46. A 28 year old long-distance runner is to undergo MR arthrography of the hip joint for a suspected labral tear. Which of the following statements is correct regarding MR arthrography?
- a. A solution of 20 mmol/L gadopentetate dimeglumine is injected into the hip joint under fluoroscopic guidance
  - b. Patients with developmental dysplasia of the hip are at increased risk of labral tears
  - c. A communication between the joint capsule and the iliopsoas bursa is always pathological
  - d. T2-weighted imaging is used to visualise the high signal of the gadopentetate dimeglumine solution
  - e. The normal labrum has uniformly high signal on T1-weighted imaging

**46. b. Patients with developmental dysplasia of the hip are at increased risk of labral tears**

The increased risk of labral tears in developmental dysplasia is due to the increased stress placed upon the acetabular rim and labrum. A communication between the joint capsule and iliopsoas bursa has been described as a normal finding in 10–15% of patients. A dilute solution of 0.2 mmol/L gadopentetate dimeglumine solution would usually be used for arthrography. A normal labrum has uniformly low signal on T1-weighted imaging with slightly increased signal on gradient echo imaging. Appearances on T2-weighted imaging can be more variable.

51. An A&E SHO has asked you to review a paediatric cervical spine plain film which has been performed on a child who has been involved in a road traffic accident. He is unsure as to whether or not the appearances are normal for a paediatric cervical spine film. Which of the following findings is more likely to represent a true cervical spine injury than a normal variant?
- a. Absence of usual cervical lordosis
  - b. Widening of the prevertebral soft tissues in expiration
  - c. Increased distance between the tips of the C1 and C2 spinous processes in flexion
  - d. Wedging of the anterior aspect of the C3 vertebral body
  - e. A 7 mm gap between the occipital condyles and the condylar surface of the atlas

51. e. A 7 mm gap between the occipital condyles and the condylar surface of the atlas. This is highly suggestive of craniocervical injury; these injuries are often fatal and are often caused by sudden deceleration. Radiologic evaluation of this injury can be difficult but is crucial in determining further management. The remainder of the findings above can all be

normal variants in the paediatric cervical spine and therefore should be interpreted with care.

- 3 Which of the following involves avascular necrosis of the vertebral body in patients aged 2–15 years, with normal discs and with an intravertebral vacuum cleft sign?
- a Legg-Calvé-Perthe disease
  - b Köhler disease
  - c Kienböck's disease
  - d Freiberg disease
  - e Calvé-Kümmel-Verneuil disease

3 Answer E: Calvé-Kümmel-Verneuil disease

Also known as vertebral osteochondrosis or vertebra plana with appearances of a uniform collapse of a vertebral body into a flat, thin disc, with increased density of the vertebra. The intravertebral vacuum cleft sign is pathognomonic. Legg-Calvé-Perthe disease (coxa plana) is idiopathic femoral head avascular necrosis (males more commonly, peak at 4–8 years). Köhler disease is avascular necrosis of the tarsal scaphoid (males, 3–10 years). Kienböck's disease is AVN of the lunate, associated with negative ulnar variance in 75%. Freiberg disease is AVN of the metatarsal heads, age 10–18 years, females more often.

- 10 A 25-year-old man with neurofibromatosis type 1 presents with back pain. What is the most common skeletal abnormality?
- a Widening of intervertebral foramina
  - b Anterior scalloping of vertebrae
  - c Scoliosis
  - d Lordosis
  - e Kyphosis



**10 Answer C: Scoliosis**

Skeletal abnormalities occur in 25–40% of cases of NF1 and the most common skeletal abnormality is scoliosis. These abnormalities are either due to pressure effects from adjacent neurofibromas or underlying mesenchymal abnormality. Erosion by neurofibromas of the intercostal nerves, leads to loss of bone of the superior and inferior aspects of the ribs and the abnormality known as ‘rib-bon ribs’. Other abnormalities include: bowing of bone, pseudoarthrosis and cystic osteolytic lesions. The vertebrae demonstrate posterior scalloping and enlargement of the intervertebral foraminae, secondary to neurofibromas of the nerve roots.

- 27** An elderly lady fell onto her back and experienced severe back and buttock pain. Pelvic radiographs revealed marked osteopenia but no definite fracture. A bone scan was then performed, which showed an H-shaped pattern of increased uptake. Which bone is likely to be involved?
- a Sacrum
  - b Ilium
  - c Ischium
  - d Pubis
  - e Fifth lumbar vertebra

**27 Answer A: Sacrum**

Osteoporotic sacral insufficiency fractures have a classical H-shaped configuration.

- 32 A 94-year-old lady was found on the floor in her nursing home. On arrival to the Emergency Department the attending doctor noticed a shortened and externally rotated right leg and radiographs of the right hip were requested. These show a minimally displaced fracture just below the right femoral neck and just above the greater and lesser trochanters. What is the treatment of choice?
- a Dynamic hip screw
  - b Uncemented hemi-arthroplasty
  - c Cannulated screws
  - d Femoral head resurfacing
  - e Total hip replacement

32 Answer B: Uncemented hemi-arthroplasty

The treatment of choice for an intra-capsular (subcapital) femoral neck fracture in an elderly patient is hemi-arthroplasty. In a younger patient group, cannulated screws could be considered. Dynamic hip screws are indicated for extra-capsular fractures where there is little risk of avascular necrosis from femoral head devascularisation.

- 35 A 47-year-old woman sustained a significant flexion injury to the cervical spine as a result of a high-velocity road traffic accident. Her spine was immobilised and she was taken to the local trauma centre for assessment. A lateral cervical spine radiograph revealed 50% anterolisthesis of C4 on C5 and malalignment of the apophyseal joints. There was no suggestion of a rotational component to the injury. What type of injury is this?
- a Stable unilateral facet dislocation
  - b Unstable unilateral facet dislocation
  - c Bilateral facet dislocation
  - d Jefferson fracture
  - e Perched facets

**35 Answer C: Bilateral facet dislocation**

This injury is inherently unstable, in contrast to unilateral facet dislocation. Severe flexion forces in combination with distraction result in complete disruption of the facet joints and displacement of the vertebral body by at least 50% relative to the one below it. A significant number are associated with traumatic disc herniation. Initial closed reduction and traction is required, but should be done judiciously as it is possible for a disc herniation to retropulse into the cervical canal.

- 37** A middle-aged gentleman who is otherwise well was shown to have coarse, vertically aligned trabeculae on a lumbar spine radiograph. A comprehensive range of blood tests were all normal. A CT of his spine was performed which showed a 'pepperpot' pattern with small dots of high density on axial images. The cortical margins were well preserved. What is the most likely diagnosis?
- a** Paget's disease
  - b** Haemangioma
  - c** Metastatic prostate carcinoma
  - d** Multiple myeloma
  - e** Lymphoma

**37 Answer B: Haemangioma**

Haemangiomas are confined to trabecular bone. Their characteristic appearance is due to resorption of trabeculae by enlarged vascular channels and thickening of the remaining trabeculae.

- 53** A 15-year-old boy was recently diagnosed with a Ewing sarcoma of his vertebral column. Which segment is most likely to be affected?
- a** Cervical spine
  - b** Thoracic spine
  - c** Lumbar spine
  - d** Sacrum
  - e** Coccyx

53 Answer D: Sacrum

When Ewing's affects the spine the sacrum is most commonly affected, followed by the lumbar, thoracic and cervical regions in that order.

60 A 39-year-old male presented with a long history of back pain and was eventually diagnosed with an ependymoma. Where was this lesion most likely to have occurred?

- a Within the skull
- b Cervical spine
- c Thoracic spine
- d Lumbar spine
- e Sacrum

60 Answer B: Cervical spine

Almost two-thirds occur in the cervical spinal cord with one-third of these showing extension to the thoracic cord. They usually extend over multiple segments (three or four on average).

64 A 42-year-old patient was investigated for acute abdominal pain and had a CT. There were features of inflammatory bowel disease and an incidental finding of a haemangioma in the L1 vertebra. Which part of the vertebra is most likely to be involved?

- a Spinous process
- b Pars interarticularis
- c Transverse process
- d Pedicles
- e Vertebral body

64 Answer E: Vertebral body

Usually in upper lumbar/lower thoracic spine. Rarely may bulge posterior cortex or extend into spinal canal leading to cord compression.



- 17 An overweight 12-year-old boy was noticed to be limping at school. There is no history of trauma but he remembers some stiffness in the right hip over the last few weeks, which improved with rest. A radiograph of the pelvis shows that a line drawn along the superior edge of the femoral neck (Klein's line) does not intersect the femoral head. What is the most likely diagnosis?
- a Septic arthritis
  - b Perthes' disease
  - c Developmental dysplasia of the hip (DDH)
  - d Slipped upper femoral epiphysis (SUFE)
  - e Blount's disease

17 Answer D: Slipped upper femoral epiphysis (SUFE)

SUFE typically occurs in overweight boys (M:F 3:1, mean age 13 in boys, 11 in girls). There are many causes and associations. Patients may present with hip or knee pain or a limp. It occurs bilaterally in less than one-third. It is graded on the extent of the femoral head slip.

- 30 A 44-year-old taxi driver was involved in a 40-mph collision with a stationary car. After assessment he was found to have a stable fracture of his cervical spine and was discharged from hospital. What injury is he most likely to have sustained?
- a Posterior arch fracture of the atlas
  - b Flexion teardrop fracture
  - c Chance fracture
  - d Clay-shoveller's fracture
  - e Bilateral interfacetal dislocation of C3/4

30 Answer D: Clay-shoveller's fracture

A clay shoveller's fracture is a stable fracture of a lower cervical vertebra spinous process, usually C7. The mechanism is sudden flexion of the neck combined with a heavy upper body and lower neck muscular contraction. This causes avulsion of the spinous process by the supraspinous ligament. A similar fracture may also occur with direct blows to the spinous process or with occipital trauma causing forced flexion of the neck. The remaining fractures are all potentially unstable.

- 32 A 54-year old lady presented with severe progressive pain in her lumbar spine. As she had a past history of breast cancer (treated with a wide local excision and radiotherapy) a Technetium-99 bone scan was requested. This showed diffuse uptake throughout the lumbar vertebrae and ribs. Which of the following anatomical sites is most suggestive of metastatic bony disease?
- a Vertebral body
  - b Lamina
  - c Pedicle
  - d Sternum
  - e Superior articular facet

32. Answer A: Vertebral body

The most common site for metastatic involvement is the anterior aspect of the vertebral body. Increased uptake in the posterior elements and especially facet joints is more suggestive of degenerative change.

- 39 An elderly gentleman presented with a two-month history of back pain. There was no history of significant osteoarthritis and no history of trauma. Plain radiographs revealed multiple sclerotic lesions scattered throughout the spine, which were confirmed as sites of increased uptake on a Tc-99 radionuclide bone scan. What primary tumour is most likely?
- a Breast
  - b Thyroid
  - c Kidney
  - d Prostate
  - e Lung

39 Answer D: Prostate

Prostate cancer is well-known for causing osteoblastic metastases. Breast and lung cancer produce mixed lytic and sclerotic metastases. Kidney and thyroid cancers are usually purely lytic.

- 60 A 38-year-old woman presented with neck pain and motor weakness and was found to have a mass at C6-T2, which was ultimately proven to be an ependymoma. In which part of the spinal canal is this lesion most likely to have originated?
- a Vertebral body
  - b Extra dural
  - c Dural
  - d Subdural
  - e Intramedullary

60 Answer E: Intramedullary

Ependymomas are intramedullary tumours.

- 64 A 42-year-old female was found to have an abnormality of T12 on CT. The vertebral body was not expanded but there was a polka dot appearance with small areas of sclerosis. Due to ongoing symptoms she was assessed with an MRI. What signal is this lesion likely to return?
- a Low signal on T1-weighted images, low signal on T2-weighted images
  - b Low signal on T1-weighted images, high signal on T2-weighted images
  - c Variable signal on T1-weighted images, high signal on T2-weighted images
  - d High signal on T1-weighted images, low signal on T2-weighted images
  - e Variable signal on T1-weighted images, low signal on T2-weighted images

64 Answer C: Variable signal on T1-weighted images, high signal on T2-weighted images

Haemangiomas return a variable but usually high signal on T1-weighted images and a high signal on T2. They are most commonly found between the ages of 10 and 50.

- 65 A 35-year-old man who presented with back pain was investigated and found to have tuberculous spondylitis. What level is most likely to be affected?
- a C3
  - b T4
  - c T8
  - d L1
  - e L5

65 Answer D: L1

Tuberculous spondylitis is also known as Pott disease. It is a destructive process and usually more than one level is affected. It occurs in less than 1% of patients with TB and is due to spread through the paravertebral venous plexus. Other radiological features include: paraspinal infection, demineralisation of endplates, collapse of vertebral body and ivory vertebrae.

- 70 A 37-year-old male had a CT of his pelvis to investigate abdominal pain and was found to have appendicitis. An incidental finding of a 7-mm enostosis (bone island) was made in his ilium. What is the most appropriate follow-up for the enostosis?
- a None
  - b Chemotherapy
  - c Radiofrequency ablation
  - d Excision
  - e Follow up CT in one year

70 Answer A: None

Enostoses are benign incidental findings that may increase slowly or decrease in size. It could be significant if at a critical load-bearing region but at 7 mm it is unlikely to be clinically relevant in the ilium.

- 1 A 20-year-old Caucasian male presented to his GP with backache. He was known to be HLA-B27 positive. Imaging of the sacroiliac (SI) joints showed bilateral symmetrical features, extensive sclerosis and erosions. Which of the following is the most likely diagnosis?
- a Osteoarthritis
  - b Ankylosing spondylitis
  - c Osteitis condensans
  - d Reiter syndrome
  - e Infection

1 Answer B: Ankylosing spondylitis (AS)

This is the most likely diagnosis because it affects younger males, with extensive sclerosis and often with erosions. AS can cause both SI joint widening and fusion. Diseases that can cause bilateral symmetrical sacroiliitis include: AS, enteropathic arthropathy, late rheumatoid arthritis, deposition arthropathy and osteitis condensans ilii.

- 2 An elderly woman has been complaining of pain in her left hip for many months. The GP is eventually persuaded to request a hip X-ray to investigate this further as the pain is far more severe than her 'regular arthritis' pains. The report from the radiologist reads 'flattening and collapse of left femoral head consistent with avascular necrosis'. Which of the following is the most sensitive in diagnosing avascular necrosis (AVN) of the hip?
- a Bone marrow imaging with radiocolloid
  - b Bone scan with diphosphonates
  - c Plain films
  - d MRI
  - e CT

## 2 Answer D: MRI

MRI is 90–100% sensitive and 80% specific for diagnosing symptomatic disease, reflecting death of marrow fat cells. Nuclear medicine scans are 80–85% sensitive, with bone marrow imaging more sensitive than bone imaging. Early disease shows a cold area from interrupted vasculature; late disease shows a ‘doughnut’ sign, a cold spot with a surrounding ring of increased uptake due to capillary revascularisation, and new bone synthesis. Plain radiographic appearances may be unremarkable in the early stages of AVN. Early diagnosis with MRI is therefore required if the diagnosis is suspected to prevent joint replacement.

- 4 A 50-year-old man presented with back pain and subsequent imaging demonstrated flowing ossification of six thoracic vertebral bodies. There was no evidence of ankylosing spondylitis and a diagnosis of diffuse idiopathic skeletal hyperostosis (DISH) was made. What further feature would be most likely on imaging?
- a Ossification of patellar ligament
  - b Sclerotic sacroiliac joints
  - c Talar osteophytes
  - d Fractures of the iliac crest
  - e Osteophytes of single vertebral bodies

## 4 Answer A: Ossification of patellar ligament

DISH is also known as Forestier disease or ankylosing hyperostosis and is an ossifying diathesis with a proliferation of entheses (bony growths at tendon and ligament insertions). DISH principally affects the spine, pelvis and extremities. The differential diagnosis includes: fluorosis, acromegaly, ankylosing spondylitis and intervertebral osteochondrosis. The features are ossification of patellar ligament, heel spurs, whiskering of the iliac crest and flowing ossification of at least four contiguous vertebral bodies.



- 7 Following acute on chronic back pain a 61-year-old female with a history of steroid use for inflammatory bowel disease is referred for further investigation. Her pelvic and lumbar spine radiographs are unremarkable. An MRI shows patchy low signal in the first sacral segment with loss of height and a radionuclide bone scan shows sacral uptake in an 'h-shaped configuration' with mild degenerative changes elsewhere. What is likely diagnosis based on the above findings?
- a Metastatic deposit
  - b Haemangioma
  - c Schmorl's node
  - d Osteoporotic collapse
  - e Insufficiency fracture

7 Answer E: Insufficiency fracture

The 'H' sign is usually diagnostic of a sacral insufficiency fracture. The sacrum can be difficult to assess on conventional radiography and its absence does not exclude pathology.

- 16 A middle-aged man presented to the Emergency Department with right hip pain that had started suddenly a few weeks previously and resulted in decreased range of movement. Plain films showed osteoporosis of the hip joint and loss of the subchondral cortex of the femoral head with preservation of the joint space. What is the most likely diagnosis?
- a Avascular necrosis
  - b Transient osteoporosis
  - c Synovial chondromatosis
  - d Disuse atrophy
  - e Villonodular synovitis

**16 Answer B: Transient osteoporosis**

This is a self-limiting disease of unknown aetiology. A characteristic is loss of subchondral cortex of the femoral head and neck region. Unlike other forms of arthritis, there is no joint space narrowing or subchondral bone collapse. Radiographic features include a joint effusion, increased uptake on bone scans, diffuse marrow oedema of the femoral head and neck (MR) and pathological fractures. There is usually spontaneous recovery within two to six months, but recurrence elsewhere is possible.

- 17** An overweight 13-year-old boy presented with hip pain. He gave no history of trauma and a radiograph showed widening and irregularity of the capital femoral epiphysis. Several weeks later he represented with worsening symptoms and a repeat radiograph showed displacement of the femoral head. In what direction is it likely the femoral head has displaced?
- a Anteroinferior
  - b Anterolateral
  - c Anterosuperior
  - d Posterolateral
  - e Posteromedial

**17 Answer E: Posteromedial**

In the preslip stages there is widening of the growth plate with irregularity. Posteromedial displacement occurs in an acute slip when the epiphysis may appear smaller due to posterior displacement. The slip is usually best seen on the lateral view.

- 33** A 44-year-old back-seat passenger who was restrained with a lap seatbelt was involved in a high-speed road traffic accident. He complained of back pain and after full assessment was found to have a vertebral fracture. A CT scan of his abdomen revealed no intra-abdominal injuries. What is the most likely level of the fracture?
- a C7
  - b T2
  - c T6
  - d L1
  - e L4

**33** Answer D: L1

A 'Chance' fracture describes a horizontal fracture through the spinous process, laminae, pedicles and vertebral body from a hyperflexion-distraction type of injury. It classically occurs as a result of deceleration affecting rear-seat passengers restrained in lap seatbelts and the thoraco-lumbar junction is the most common site of injury. A CT scan is the best modality for evaluating these fractures and other associated injuries (50% incidence of abdominal injuries with Chance fracture). Immobilisation is generally adequate treatment for these fractures; however, kyphosis of greater than 20 degrees is an indication for surgical fixation and spinal cord decompression as there may be instability.

- 58** A female neonate was born prematurely after a pregnancy complicated by polyhydramnios. A USS of the sacral region demonstrated an 18-cm solid cystic mass and pelvic X-ray demonstrated a mass with amorphous calcification. What blood test would be most helpful in making the diagnosis?
- a** Beta HCG
  - b** Full blood count
  - c** Alpha feta protein
  - d** Liver function tests
  - e** Urea and electrolytes

**58** Answer C: Alpha feta protein

Sacroccygeal teratoma is the most common solid tumour occurring in the newborn and alpha feta protein is raised in malignant teratomas. It is more common in girls and is associated with other congenital anomalies such as spinal dysraphism, sacral agenesis, hydronephrosis, imperforate anus and gastroschisis. Sacroccygeal teratomas are typically mixed cystic/solid and on MRI they are heterogeneous with high signal on T1-weighted images. The older the child is at presentation the more likely the tumour is to be malignant.

- 59 A 55-year-old man had a history of renal cell carcinoma treated with a radical nephrectomy 10 months previously (T4N1M0). He was thought to be in remission but developed bony pain in his lumbar spine. Lumbar radiographs revealed an abnormality that showed increased uptake on a subsequent Tc-99MDP bone scan. What is the most likely appearance of this lesion on the plain film?
- a Expansile, lytic lesion
  - b Non-expansile, lytic lesion
  - c Expansile, sclerotic lesion
  - d Non-expansile sclerotic lesion
  - e Non-expansile, mixed sclerotic/lytic lesion

59 Answer A: Expansile, lytic lesion

Thyroid and renal cell carcinoma metastases are nearly always osteolytic. Other causes of lytic metastases include melanoma, lung and breast carcinomas. The most common causes of sclerotic metastases are prostatic, breast, colonic and bladder carcinomas in addition to melanoma and soft-tissue sarcomas.

- 60 A 29-year-old male presented with difficulty walking and was found to have a complex sensory deficit. After investigation he was found to have an astrocytoma of the spinal cord. Which area is most likely to be involved?
- a Brainstem
  - b Cervical spine
  - c Thoracic spine
  - d Lumbar spine
  - e Sacrum

60 Answer C: Thoracic spine

Almost two-thirds occur in the thoracic spinal cord, although half involve the cervical cord as they usually extend over a long region of cord (approximately seven segments on average).

**1. A 50-year-old man who has been previously well presents with low back pain. Plain film reveals an osteolytic midline lesion in the lower sacrum containing secondary bone sclerosis in the periphery, as well as amorphous peripheral calcifications. A lateral film shows anterior displacement of the bladder and rectum. He subsequently develops faecal incontinence. No additional lesions were discovered after imaging of the whole spine. What is the most likely diagnosis?**

- A. Osteomyelitis.
- B. Ewing's sarcoma.
- C. Chordoma.
- D. Myeloma.
- E. Sacrococcygeal teratoma.

**1. C. Chordoma.**

Plain film is very insensitive for detecting sacral lesions. Metastatic disease is much more common in the sacrum than primary malignancy. Chordoma is the most common primary sacral lesion. It is derived from the embryonic remnants of the notochord and is thus almost always found in the midline or a paramedian location with respect to the spine. It is most commonly found in the sacrum (50%), clivus (35%), and vertebrae (15%). A chordoma manifests as a destructive, lytic lesion, commonly with internal calcifications, at both plain radiography and CT. A large presacral soft-tissue component is usually present, as are soft-tissue components within the sacrum and sacral canal. Symptoms can include pain, sciatica, and rectal bleeding as well as other bowel and bladder symptoms, reflecting compromise of sacral nerves. The tumours can extend across the adjacent disc space and sacroiliac joint.

On MRI, chordomas demonstrate low to intermediate signal intensity on T1WI and prominent increased signal intensity on T2WI. Enhancement of the soft-tissue components is variable, yet often moderate, on both CT and MR images. Chordomas demonstrate a prominent vascular stain at angiography. They are locally aggressive and develop in locations that do not permit easy surgical cure. There is an almost 100% recurrence rate; tumour seeding along biopsy tracts and surgical incisions can lead to multicentric local recurrences. Metastasis occurs in 5–43% to liver, lung, regional lymph nodes, peritoneum, skin, and heart. The 5-year survival rate is 66% for adults.

Osteomyelitis in the sacrum is most often due to contiguous spread from a suppurative focus and we are told this patient was previously well. Ewing sarcoma would occur at a younger age (peaking at 15 years, 90% manifest between the ages of 5 and 30). In the case of myeloma it would be atypical for the rest of the spine to be uninvolved. The sacrococcygeal region is the most common location of teratomas discovered in infancy. It is only rarely discovered in adulthood. Teratomas are composed of a mixture of cystic and solid components.

The other lesions to be included in the differential diagnosis of such a sacral mass are metastasis, sarcomas, GCT, chondrosarcoma, and ependymoma.



4. A 63-year-old female is being worked up for a left total hip replacement. She has a history of RA. As part of the routine pre-operative assessment in your hospital a cervical spine radiograph is requested. This demonstrates that there is widening of the pre-dental space, with the anterior arch of C1 located anterior to the lower part of the body of C2. The dens is not clearly visible. This appearance is constant on the flexion view. The patient is asymptomatic. What do you think these findings represent?
- A. Degenerative change.
  - B. Pannus erosion of dens.
  - C. Atlanto-axial subluxation.
  - D. Erosion of the occipital condyles.
  - E. Atlanto-axial impaction.

4. E. Atlanto-axial impaction.

This is a more severe form of atlanto-axial subluxation where the C1-2 facets collapse and there is invagination of the dens of C2 into the foramen magnum. As such, the dens is not visible on the lateral radiograph. The key feature, apart from widening of the pre-dental space (which can also be caused by pannus eroding the dens or more commonly atlanto-axial subluxation), is that the anterior arch of C1 lies in front of the lower portion of C2, whereas it normally lies anterior to the dens.

14. A 60-year-old man presents to the A&E department with acute onset lower back pain following a relatively minor fall. A plain film reveals a collapse of the L4 vertebral body against a background of osteopenia. He has a history of renal cell carcinoma and the clinical team request an MRI to 'rule out metastatic disease'. Which of the following features would most suggest a malignant rather than a benign cause for a vertebral compression fracture?
- A. Isointense signal to adjacent vertebral bodies on T2WI.
  - B. A band-like area of low signal adjacent to the fractured end-plate on T1WI.
  - C. High signal intensity adjacent to the vertebral endplate on STIR imaging.
  - D. Retropulsion of a posterior fragment into the spinal canal.
  - E. A convex bulge involving the whole of the posterior cortex of the vertebral body.



**14. E.** A convex bulge involving the whole of the posterior cortex of the vertebral body.

The others are more in keeping with benign compression fractures. Retropulsion of a posterior fragment into the spinal canal is a highly specific (100%) finding of benign compression fracture, but has a sensitivity of only 16%. Other features in keeping with malignant compression fractures are complete replacement of normal marrow with low signal on T1WI, involvement of the pedicles, and the presence of an epidural and/or paraspinal soft-tissue mass. The presence of an epidural mass is said to have 80% sensitivity and 100% specificity for malignant fractures. Convex bulging of the posterior cortex of the vertebra and involvement of the pedicle have respective sensitivities and specificities of 70% and 94%, and 80% and 94%. Beware that compression fractures due to multiple myeloma only rarely show MRI features of malignant fracture and this diagnosis should be included in the differential of a non-traumatic, benign-appearing vertebral compression fracture.

**31. A 35-year-old male presents with a history of backache. Plain radiograph demonstrates reduction in the lumbar L2-3 disc space with mild endplate irregularity. An MRI of lumbar spine is carried out for further assessment. What feature on MRI is useful in differentiating discitis from modic type I endplate change?**

- A. Reduction in the disc height.
- B. Low signal change in the endplate on T1WI.
- C. High signal change in the endplate on T2WI.
- D. Mild irregularity of the endplates.
- E. High signal within the disc on T2WI.

**31. E.** High signal within the disc on T2WI.

Degenerative disc disease with associated degenerative modic type 1 endplate change (endplate oedema) can mimic discitis. All the mentioned changes are seen in both conditions except high signal within the disc on T2WI, which is seen in infection/discitis. In contrast, the degenerated disc is of low signal due to loss of hydration.

In addition, disc enhancement and paravertebral inflammatory tissue, soft-tissue mass, and fluid collection are associated with infection.

**39. A 30-year-old man presents with backache and morning stiffness. Examination reveals loss of spinal movement, uveitis, and upper zone end inspiratory fine crepitations on auscultation. Which of the following statements is most correct in relation to the radiological features of the underlying condition?**

- A. Romanus lesions (anterior or posterior spondylitis) are a late feature.
- B. Syndesmophytes are better depicted on MRI than plain film.
- C. Ankylosis involves the vertebral edges or centre.
- / D. Sacroiliac joint widening is not a feature.
- E. Enthesitis appears as low signal within the ligaments on STIR imaging.

**39. C.** Ankylosis involves the vertebral edges or centre.

The question refers to ankylosing spondylitis. Ankylosis involves the vertebral edges or centre, with bony extension through the disc. The former is thought to be secondary to a Romanus lesion, the latter an Andersson lesion. Romanus lesions are irregularities and erosions involving the anterior and posterior edges of the vertebral endplates and are the earliest changes of spondylitis depicted on conventional radiographs. On MRI an Andersson lesion is depicted as disc-related signal-intensity abnormalities of one or both vertebral halves of a disc/vertebral unit. They are often hemispherically shaped. MRI is better than conventional radiography at depicting Romanus lesions, Andersson lesions (spondylodiscitis), and most other abnormalities, although ankylosis is equally well detected by both modalities.

Syndesmophytes are difficult to detect on MRI. Plain radiography is superior in this respect because of its superior spatial resolution; syndesmophytes are seen as bony outgrowths of the anterior vertebral edges. They occur in 15% of the vertebrae of patients. Apical pulmonary fibrosis affects 1% of patients. Sacroiliac (SI) joint erosion and widening is an early feature, and this may initially be more prominent on the iliac side of the joint, as the cartilage on that side is normally thinner. Later in the disease, sclerosis and ankylosis occur and the SI joints become symmetrically fused. Enthesitis is most prominently seen when the interspinous ligaments, those that extend between the spinous processes, and the supraspinal ligaments are affected. Ligamentous involvement is characterized by an increased signal intensity on either STIR images or contrast-enhanced T1WI fat saturated sequences. It may be associated with osteitis of adjacent bone marrow in the spinous processes. Arthritis of the synovial joints (e.g. facet joints) and insufficiency fractures (often spontaneous or after minor trauma) are also features of the seronegative spondylarthritides.



**49. A 76-year-old man presents with hip and pelvic pain. He has a past history of renal cell carcinoma treated by radiofrequency ablation, and has been treated on multiple occasions with heparin for thromboembolic disease. Plain films are non-contributory but a  $^{99m}\text{Tc}$  bone scan reveals increased thoracic kyphosis and increased uptake in the body and bilateral alae of the sacrum in an H configuration. What is the most likely diagnosis?**

- A. Brown tumour.
- B. Multiple myeloma.
- C. Metastasis from renal cell carcinoma.
- D. Chordoma.
- E. Insufficiency fractures.

**49. E. Insufficiency fractures.**

This patient has developed osteoporosis due to heparin administration (and with age). This has resulted in thoracic kyphosis and the 'H' sign of increased uptake within the sacral body and alae, which is classical of insufficiency fractures of the sacrum. Often there will have been relatively minor trauma that will not be reported by the patient, and there may be associated pubic rami fractures. Radiotherapy to the area (e.g. in gynaecological malignancy) is another predisposing factor.

Multiple myeloma, metastases from renal cell carcinoma, and chordoma are typically osteolytic and result in osteopenia at isotope bone scan (IBS), although the investigation has poor sensitivity for myeloma. Brown tumours do cause increased uptake on IBS, but we are not given a history of renal failure or hyperparathyroidism to explain their presence. There is no history given to suggest infection.

Bone metastases which cause an increased uptake on IBS are breast, prostate, lymphoma, pulmonary carcinoid, mucinous GI, and bladder tumours. Renal cell carcinoma, thyroid, and melanoma typically cause photopenia.

**52. A 24-year-old male patient is referred from the rheumatologists with a history of back pain and hip pain. Plain films are carried out. These show bilateral sacroiliitis with erosive change on the iliac side on the left, but sacral and iliac erosions on the right. The imaging of the spine reveals large non-marginal syndesmophytes in the thoracolumbar spine with a relatively normal lower lumbar spine. The patient also complains of foot pain and plain films reveal evidence of a retrocalcaneal bursitis with erosion of the calcaneus. Hand x-rays reveal small erosions asymmetrically in the distal IP joints in both hands. What is the most likely diagnosis?**

- A. Ankylosing spondylitis.
- B. Reactive arthritis.
- C. Psoriatic arthritis.
- D. Erosive OA.
- E. Adult Still's disease.

**52. C. Psoriatic arthritis.**

Ankylosing spondylitis causes a symmetrical sacroiliitis. The syndesmophytes associated with this are marginal and fine. It also typically progresses superiorly from the lumbar spine. Both reactive arthritis and psoriatic arthritis cause an asymmetric sacroiliitis and the syndesmophytes are usually centred on the thoracolumbar spine and are non-marginal and bulky. Retrocalcaneal bursitis and erosions, whilst more common in reactive arthritis, can occur in psoriatic arthritis, and reactive arthritis would uncommonly affect the hands. Also, with all other factors being equal, psoriatic arthritis is much more common than reactive arthritis, even without the skin manifestations, which are absent in up to 20% at presentation.

**53. A 34-year-old man has an MRI of the lumbar spine for lower back pain. This is normal apart from a focal lesion present in the L4 vertebral body. This is reported as a vertebral haemangioma. Which of the following MRI characteristics does this lesion most likely have?**

- |   |     |       |
|---|-----|-------|
| A. ↓T1                                  | ↓T2 | ↓STIR |
| B. ↓T1                                  | ↓T2 | ↑STIR |
| C. ↓T1                                  | ↑T2 | ↓STIR |
| D. ↑T1                                  | ↓T2 | ↓STIR |
| E. ↑T1                                  | ↓T2 | ↑STIR |
| <input checked="" type="radio"/> F. ↑T1 | ↑T2 | ↓STIR |
| G. ↑T1                                  | ↑T2 | ↑STIR |

**53. E. ↑T1 ↑T2 ↓STIR**

The variable proportions of vascular and fatty soft-tissue elements influence the MRI appearance of haemangiomas. Lesions with a predominantly fatty matrix show high signal intensity on T1WI, intermediate to high signal intensity on T2WI, and loss of signal on STIR or fat-suppressed T2WI. If the vascular elements predominate, the lesions appear hypointense on T1WI and extremely hyperintense on STIR and T2WI. If MRI is inconclusive, CT may be helpful in identifying the typical pattern of haemangiomatous bone replacement, such as the honeycomb, 'soap bubble' or 'sunburst' appearance.

**62. A 55-year-old man is noted on a plain x-ray of pelvis to have a right hip prosthesis. There is a cemented acetabular component present with an uncemented stem. Of the following hip arthroplasties, which is the most likely procedure that he has undergone?**

- A. Unipolar hemiarthroplasty.
- B. Bipolar hemiarthroplasty.
- C. Hip resurfacing.
- D. Hybrid total hip replacement.
- E. Reverse hybrid total hip replacement.

**62. E.** Reverse hybrid total hip replacement.

A combination of a cemented acetabular cup and an uncemented femoral stem is known as a reverse hybrid hip total hip replacement. A hybrid total hip replacement is a combination of a cemented femoral stem and an uncemented acetabular cup.

A unipolar hemiarthroplasty comprises a combination of a femoral component articulating directly with the native cartilage surface of the acetabulum.

A bipolar hemiarthroplasty comprises a combination of a femoral component articulating with a cup inserted into the native acetabulum without fixation. This cup is usually made of polyethylene with a metal backing and can normally move within the native acetabular cavity as a result of the absence of fixation.

Hip resurfacing consists of replacing the surface of the femoral head by a metallic 'cap' without removing the femoral neck or instrumenting the femoral diaphysis. The cap used on the femoral head is virtually the same size as the natural head and articulates with an acetabular prosthetic cup, usually made of metal. This type of procedure is favoured in younger active patients and may allow for easier revision to a total hip replacement in later years.



**67. A 22-year-old patient presents to casualty with a reduced GCS and hypotension. He is visiting the UK from abroad and fellow backpackers in a local youth hostel state that he was complaining of abdominal pain earlier that day. A CT abdomen reveals sclerosis in both femoral heads and H-shaped vertebrae. The spleen is small and calcified. What is the patient's most likely underlying diagnosis?**

- A. Scheuermann's disease.
- B. Hereditary spherocytosis.
- C. Gaucher disease.
- D. Sickle-cell disease.
- E. Primary bone lymphoma.

**67. D. Sickle-cell disease.**

Gaucher disease and SCD can both cause H-shaped vertebrae and avascular necrosis of the humeral heads, but Gaucher disease causes splenomegaly, whereas by adulthood SCD will usually have caused splenic infarction, resulting in a small, calcified spleen. Films illustrating the complications of these diseases are beloved by examiners in the 2B exam: remember to look for the mediastinal mass (extramedullary haematopoiesis) and AVN of the proximal humeri on the chest film.

Other musculoskeletal manifestations of SCD include osteomyelitis (particularly *salmonella* species), septic arthritis, and medullary bone infarcts. Infarction in SCD is common throughout the body and is responsible for the acute pain crisis. Infarction can occur in the liver, spleen, and kidneys, and can result in stroke.

Scheuermann's disease is osteochondrosis of the apophyses of the thoracic vertebrae and results in end-plate irregularity, Schmorl's nodes, loss of disc space, and kyphosis. True H-shaped vertebrae are not a feature.

Hereditary spherocytosis is an autosomal dominant condition. It produces splenomegaly and, as with other haematological conditions, can result in widening of the diploic spaces of the skull.

Primary bone lymphoma typically appears as a solitary focal lesion with an aggressive appearance.

- 3 A 78 year old woman has left hip pain following a fall. On examination the left hip is shortened and externally rotated. X-rays show a fracture of the left neck of femur.

Which of the following fractures is at highest risk of avascular necrosis?

- (a) Basi-cervical fracture
- (b) Inter-trochanteric fracture
- ✓ (c) Sub-capital fracture
- (d) Sub-trochanteric fracture
- (e) Trans-cervical fracture

Subcapsular

subcapital

transcervical

basicervical

extracapsular

Intertrochanteric

subtrochanteric

The more proximal the subcapsular fr., the greater the risk of vascular compromise ⇒ ↑ risk of AVN

3 (c)

Proximal femoral fractures are divided in subcapsular and extracapsular. The joint capsule runs from the acetabulum to the inter-trochanteric line anteriorly and to the junction of the middle/ distal third of the femoral neck posteriorly. Thus intracapsular fractures are those of the femoral neck: sub-capital, trans-cervical and basi-cervical fractures, and extracapsular include inter-trochanteric, sub-trochanteric and femoral shaft fractures. Intracapsular fractures are more susceptible to AVN because the main supply to the femoral head is from the circumflex femoral arteries, which enter *via* the capsule and are more likely to be disrupted by such fractures. Additional blood supply from the ligamentum teres artery *via* the acetabular fossa and the retinacular branches on the surface of the femoral neck, are usually insufficient to prevent AVN. Furthermore they may be compromised by the raised pressure secondary to blood within the joint capsule. The more proximal the subcapsular fracture, the greater the risk of vascular compromise, thus a sub-capital fracture has the greatest risk of AVN.

- 16 A patient presents with back pain. He is found to be HLA-B27 positive and a diagnosis of ankylosing spondylitis is suspected. Plain films of the spine are requested.

Which of the following would be the least supportive of this diagnosis?

- (a) Calcification of the anterior longitudinal ligament
- (b) Osteitis
- (c) Syndesmophytes
- (d) Sclerosis of the costotransverse joints
- (e) Ankylosis of the costovertebral joints

16 (a)

Ossification of the posterior, rather than anterior longitudinal ligament is typical of ankylosing spondylitis.

- 17 You are asked to review a series of plain films of the cervical spine of an adult patient.

Which of the following is abnormal?

- (a) On the lateral view, the distance between the anterior arch of C1 and the anterior aspect of the odontoid peg is 2 mm
- (b) On the lateral view, the soft tissues anterior to C2 are 9 mm thick
- (c) Harris' white ring is incomplete in its inferior aspect
- (d) On the lateral view, the C4-5 interspinous distance is 30% greater than the C5-6 interspinous distance
- (e) On the lateral view, the soft tissues anterior to C6 are 20 mm thick

17 (b)

The distance between the anterior arch of C1 and the anterior aspect of the odontoid peg should be no more than 3 mm in an adult. On the lateral view, the maximum width of the prevertebral soft tissues is: 7 mm at C1-4, 22 mm at C5-7. Harris' ring is often incomplete in its inferior aspect. On the long AP view, no single interspinous distance should be more than 50% wider than the one immediately above or below it.

18 A pregnant lady suffers from sudden, spontaneous hip pain, worsened by weight bearing. The range of movement is relatively well preserved. Plain radiographs and an MR examination are performed.

*Transient osteoporosis ⇒ edema of the head.*

**Which of the following would be more suggestive of avascular necrosis rather than transient osteoporosis of the hip?**

- (a) Acetabular oedema on MR imaging
- (b) A 'double line' sign on MR imaging
- (c) Osteoporosis on plain radiographs
- (d) Increased uptake in the femoral head on  $^{99m}\text{Tc}$ -MDP imaging
- (e) Preservation of the articular cartilage on MR imaging

18 (b)

Transient osteoporosis of the hip is a sudden, painful but self limiting condition, first described in patients in the third trimester of pregnancy, but seen most frequently in middle-aged men. Radiographs show diffuse osteopaenia 4–8 weeks after symptom onset. MR imaging demonstrates diffuse oedema, without focal defects: oedema localised to the subchondral surface or a 'double-line' sign suggest AVN.  $^{99m}\text{Tc}$ -MDP imaging shows homogeneously increased uptake in the femoral head and neck.

**19 An 8 year old child presents with a limp. Which of the following would favour a diagnosis of bacterial infection over Perthe's disease?**

- (a) A smaller femoral epiphysis than on the contralateral side
- (b) Joint space widening
- (c) Destruction of the articular cortex
- (d) Alteration of the periarticular soft tissue outline
- (e) Localised bone demineralization

**19 (c)**

Articular cortex destruction is not seen in Perthe's disease, which classically demonstrates sclerosis of the femoral head along with the findings above in the early phase. Later changes include subchondral fractures, femoral head fragmentation, femoral neck cysts and loose body formation.

**20 A young man is involved in an RTA and arrives in hospital with a markedly reduced GCS. Anterior tilt of the odontoid peg is noted and an oblique fracture line is seen through the upper portion of the dens.**

**Which type of odontoid fracture is this?**

- (a) Type I
- (b) Type II
- (c) Type III
- (d) Type IV
- (e) Type V



*3 mm 2.5 x 10*

**20 (a)**

Type I: a fracture through the upper portion of the dens. Type II: a transverse fracture through the junction of the dens and the body of the axis. Type III: a fracture through the body of the axis. There is no type IV nor V.



- 25 A 32 year old presents with acute abdominal pain. An AXR demonstrates calcification in the LUQ, with loops of bowel in this region, central depressions in the superior and inferior endplates of L3 and L4, and a mixed lysis/sclerosis appearance to the superior aspect of the left femoral head.

What is the likely unifying diagnosis?

- (a) Achondroplasia
- (b) Hyperparathyroidism
- (c) Lymphoma
- (d) Renal osteodystrophy
- ✓ (e) Sickle cell disease

H-shaped vertebrae

AVN of femur

auto-infarction of spleen

hair on end appearance to the skull

osteomyelitis

25 (e)

The described findings are of an H-shaped vertebrae (often better appreciated on lateral films), left femoral head AVN, and auto-infarction of the spleen. In SCD, the Hb deforms at low oxygen tension, and obstructs small blood vessels, leading to hypoxia/ anoxia (AVN), and splenic auto-infarction (on AXR: prominent bowel loops in the LUQ +/- calcification of the spleen). Other skeletal features include 'hair-on-end' appearance to the skull, secondary osteomyelitis (often due to *Salmonella*), and premature epiphyseal fusion. Cholelithiasis, cardiomegaly, PE, cerebral infarcts, and renal papillary necrosis are also associated.

**32 Regarding idiopathic scoliosis.**

**Which of the following statements is true?**

- ✓ (a) Adolescent idiopathic scoliosis is the commonest form
- (b) It affects males more than females *x Females > male*
- (c) There is a worse prognosis with lumbar scoliosis *x Thorax scoliosis = worst prog.*
- (d) Scaphocephaly is associated with infantile idiopathic scoliosis
- (e) Subtle neurological abnormalities can be expected

**32 (a)**

Scoliosis can be divided into three broad categories: congenital, idiopathic, and secondary. Idiopathic scoliosis is described as infantile (0–3 years), juvenile (4–10 years), adolescent (> 10 years), or adult onset. Adolescent idiopathic scoliosis accounts for 80% of cases, and rapid progression tends to occur during growth spurts. Prognosis is worse with a high thoracic scoliosis. Females are more commonly affected. The presence of neurological signs implies an underlying abnormality. Plagiocephaly is associated with infantile idiopathic scoliosis.

**37 An MRI examination of the lumbar spine demonstrates endplates with reduced signal intensity on T1W and increased signal intensity on T2W. *Common at L4-L5 & L5-S1***

**What is the most appropriate diagnosis?**

- (a) Normal
- (b) Type I Modic change *Fluid ↓ T1 ↑ T2*
- (c) Type II Modic change *Fat ↑ T1 ↓ T2 due to red marrow replacement*
- (d) Type III Modic change *Sclerotic ↓ T1 ↓ T2*
- (e) Type IV Modic change

*There is no type IV*

**37 (b)**

Modic degenerative changes are bone marrow and endplate changes adjacent to degenerative lumbar intervertebral discs; they are commonest at the L4-L5 and L5-S1 level. Modic II is more prevalent, but Modic I changes are more likely to be symptomatic. Type I changes have MRI appearances of fluid (low T1, high T2), type II changes have the characteristics of fat due to red marrow replacement (high T1 and T2), and type III changes are due to sclerosis (low on T1 and T2).

**43 A CT is performed following major trauma. A Hangman's fracture is suspected.**

**Which of the following features would be unusual with this diagnosis?**

- (a) Avulsion of the anteroinferior corner of C2
- (b) Posterior subluxation of C2 on C3
- (c) Bilateral pars fracture of C2
- (d) Prevertebral soft tissue swelling
- (e) Disruption of the C1-C2 spinolaminar line

**43 (b)**

The Hangman's fracture is a traumatic bilateral neural arch fracture, most commonly of the pars, resulting from hyperextension. When subluxation occurs, it is more commonly an anterior, rather than posterior subluxation of C2 on C3.

- 49 The pelvic radiograph of a young woman reveals bilateral, symmetrical triangular areas of subchondral sclerosis on the inferior aspect of the iliac side of the joint. The joint spaces are normal and the joint margin is well-defined. There is no evidence of bone or joint disease elsewhere.

**What is the most likely diagnosis?**

- (a) Osteitis condensans ilii → young multiparous woman  
(b) Infection  
(c) Osteoarthritis  
(d) Hyperparathyroidism  
(e) Alkaptonuria

**49 (a)**

Osteitis condensans ilii produces this radiographic appearance, typically in young multiparous women. Possible differential diagnoses include: ankylosing spondylitis, rheumatoid arthritis (both would be associated with joint space changes) and Paget's disease.

- 2 A gentleman presents to A&E after trauma. Plain radiographs of the cervical spine are taken. There is an abrupt transition in the alignment of the cervical spine at C5-6, with anterolisthesis of C5 on C6 by 3/4 of a vertebral body's width.

**Which of the following is incorrect?**

- (a) There is a high incidence of cord injury  
(b) This is a stable dislocation  
(c) The posterior ligament complex is disrupted  
(d) The anterior longitudinal ligament is disrupted  
(e) The facets may be in a 'batwing' or 'bow-tie' configuration

**2 (b)**

Given the extent of anterolisthesis (>50% of a vertebral body), this is most likely to represent bilateral, rather than unilateral facet dislocation, and therefore an unstable injury.

- 5 An MRI examination of the lumbar spine demonstrates 5 mm of intravertebral disc tissue protruding beyond the margin of the vertebral body over 60% of the vertebral body circumference.**

**What is the most appropriate diagnosis?**

- (a) Annular disc bulge
- (b) Broad based disc herniation
- (c) Focal disc herniation
- (d) Intravertebral herniation
- (e) Disc sequestration

**5 (a)**

In an annular disc bulge, disc tissue extends beyond the adjacent vertebral bodies by at least 3mm for more than 50% of the disc circumference. This is associated with degenerative disease and is not regarded as a true herniation.

- 12 A CT is performed following major trauma. A cervical burst fracture is suspected.**

**Regarding this condition, which of the following statements is incorrect?**

- (a) Interpedicular widening is common
- (b) Injury to the spinal cord is common
- (c) There are commonly fragments within the spinal canal
- (d) There is loss of posterior vertebral body height
- (e) This is considered an unstable fracture

**12 (e)**

This is considered to be a stable fracture. All patients require CT to identify fracture fragments (most commonly from the posterior, superior margin) within the spinal canal.



- 13 An elderly patient has increasing back pain and weight loss. There is local tenderness over the upper lumbar vertebrae. Plain radiographs and MR imaging is performed. A history of tuberculosis is noted.

**Which of the following features would be more supportive of a pyogenic, rather than tuberculous spondylodiscitis?**

- (a) Marked vertebral collapse
- (b) Early bridging of affected vertebrae
- (c) A large paravertebral abscess
- (d) A pulmonary lesion
- (e) Slow progression

13 (b)

It is difficult to differentiate tuberculous from pyogenic spondylodiscitis, however a number of features may point towards TB: slower progression, marked vertebral collapse, a large paravertebral abscess (which may be calcified) and a reduced osteoblastic response. In addition, pyogenic infection tends to result in earlier bridging of the affected vertebrae.

- 16 A middle aged man presents with low back pain and faecal incontinence. MR imaging of the lumbar spine is performed and a diagnosis of chordoma is subsequently made.

**Regarding the chordomas, which of the following is incorrect?**

- (a) They typically have poor uptake of  $^{99m}\text{Tc}$ -MDP
- (b) They usually cause extensive local bone destruction
- (c) They most frequently arise in the sacrum or coccyx
- (d) They may have a narrow zone of transition
- (e) Metastasis is common

**16 (e)**

Chordomas arise from notochord remains and are therefore limited to the clivus, spine, sacrum and coccyx. Metastasis is uncommon, but when it does occur, lung secondaries are typical. Tumour size (the average size of a sacrococcygeal chordoma is 10 cm), lytic nature and location are important clues to the diagnosis.

**17 A young man avulses his anterior inferior iliac spine whilst kicking a football.**

**The origin of which muscle will be affected?**

- (a) Adductor magnus
- (b) Iliopsoas
- (c) Rectus femoris
- (d) Sartorius
- (e) Tensor fasciae latae

**17 (c)**

The anterior inferior iliac spine is the origin of rectus femoris.

**18 A man falls from a balcony and is brought into A&E. There is clinical shortening of the left leg and plain radiographs demonstrate fractures through the left sacroiliac joint and the left pubic rami.**

**What is the most appropriate description of this fracture?**

- (a) Bucket-handle
- (b) Duverney
- (c) Open-book
- (d) Malgaigne
- (e) Wide-swept pelvis

**18 (d)**

A Malgaigne fracture typically involves two fractures, both on the same side of the pelvic ring: one anterior to the acetabulum (e.g. both pubic rami) and one posterior to the acetabulum (e.g. through the ilium, or the SI joint).

**21 On MR imaging, an elderly gentleman is noted to have an acute compression fracture of a lumbar vertebra.**

**Which of the following features would be more suggestive of a malignant, rather than benign cause for the fracture?**

- (a) The vertebral body returns low signal on T1W in the acute phase
- (b) Enhancement after *i.v.* gadolinium
- (c) The vertebral body returns intermediate signal on T1W two months after the fracture
- (d) Involvement of the anterior elements
- (e) The overall mass of the vertebral body is increased

**21 (e)**

In the acute phase, low T1W signal is returned from the vertebral body in both malignant and benign causes. In benign disease, the low signal will return to normal over 4-6 weeks; in malignant disease the low T1W signal is retained. Enhancement with *i.v.* gadolinium is non-specific. In benign disease, the overall mass of the vertebral body is diminished, in contra-distinction to malignancy, where it is increased.

- 26 A 32 year old previously well woman presents with a 4 week history of unilateral hip pain. There is no history of trauma or evidence of sepsis. Plain film shows marked unilateral osteoporosis of the femoral head and neck with loss of the subchondral cortex of the femoral head and neck.**

**Which of the following statements is incorrect with regard to the most likely diagnosis?**

- (a) This condition is more common on the left side
- (b) Joint space narrowing is a common feature
- (c) Increased uptake on bone scintigraphy is typical
- (d) It is more common in men
- (e) A small joint effusion on MRI is often seen

**26 (b)**

Transient osteoporosis of the hip is a self limiting disease of unknown aetiology typically affecting one joint at a time. Bone marrow oedema is seen on MRI. Joint space narrowing is not a feature. It is associated with pregnancy although still more common overall in middle aged men.

- 29 A lesion is noted within the marrow of a vertebral body. MR imaging reveals high signal intensity on both T1 and T2W imaging.**

**Which of the following processes would be consistent with these appearances?**

- (a) Lytic bone metastases
- (b) Sclerotic bone metastases
- (c) Modic type I changes
- (d) Lymphoma
- (e) Haemangioma

**29 (e)**

Haemangiomas tend to return high signal on both T1 and T2 weighted sequences. All the other options listed would return low signal on T1 sequences.

**30 A pelvic radiograph reveals sacroiliitis. This is most prominent on the lower and middle thirds of the joints, particularly on the iliac side. The changes are bilateral and symmetrical.**

**These appearances are most commonly seen in which of the following conditions?**

- (a) Reiter's syndrome
- (b) Rheumatoid arthritis
- (c) Gouty arthritis
- (d) Osteoarthritis
- (e) Ankylosing spondylitis

**30 (e)**

Ankylosing spondylitis typically produces a bilateral, symmetrical sacroiliitis, whilst the other conditions typically result in bilateral but asymmetrical disease. Other conditions producing bilateral, symmetrical sacroiliitis include: inflammatory bowel disease, psoriatic arthropathy, osteitis condensans ilii, hyperparathyroidism and paraplegia.

**34 Which of the following is a contraindication to percutaneous vertebroplasty?**

- (a) Myeloma metastasis
- (b) Vertebral body haemangioma
- (c) Previous vertebroplasty in an adjacent vertebra
- (d) Fractures involving the posterior elements
- (e) Sclerotic metastases



**34 (d)**

Other absolute contraindications include bleeding diathesis, acute fractures not responding to bisphosphonate treatment within 2 weeks and those where the level of collapse cannot be clearly defined.

**36 A 35 year old man involved in an RTA presents to A&E with lower neck pain. The mechanism of injury is thought be one of flexion. Cervical and thoracic spine films are obtained.**

**Which of the following flexion fractures would you describe as being unstable?**

- (a) Anterior subluxation
- (b) Clay-Shoveler's fracture
- (c) Flexion teardrop fracture
- (d) Unilateral facet joint dislocation
- (e) Wedge compression fracture

**36 (c)**

Neutral films infer stability based on fracture type; stability is a function of ligamentous injury and thus cannot be implied with 100% accuracy, if doubt remains MRI or flexion/ extension views should be obtained. The other type of unstable flexion injury is a bilateral facet joint dislocation. Unstable extension injuries include Hangman's fracture and hyperextension-dislocation fracture; stable extension injuries include posterior arch of C1 fracture, laminar fracture, Pillar fracture, and extension teardrop fracture. Jefferson's fracture is an unstable compression fracture, burst fracture a stable one. 'Complex' unstable fractures include odontoid fracture and atlanto-axial disassociation.

- 45 A 25 year old man presents with chronic back pain. X-rays show bilateral irregularity of the sacro-iliac joints and paravertebral ossification on the AP view. Radiographs of the feet demonstrate destruction of the interphalangeal joint of the great toe with an exuberant periosteal reaction and bony proliferation at the distal phalangeal base.**

**Which of the following is the likeliest diagnosis?**

- (a) Ankylosing spondylitis
- (b) Rheumatoid arthritis
- (c) Psoriatic arthritis
- (d) Reiter's syndrome
- (e) Inflammatory bowel disease

**45 (c)**

The changes in the feet are characteristic of psoriatic arthropathy with soft tissue swelling and erosive changes leading to a 'pencil-in-cup' deformity. When seen, the changes at the interphalangeal joint of the great toe are pathognomonic. The SI joints are involved in 40% of cases and involvement can be either uni- or bi-lateral. As with Reiter's syndrome, a large bulky paravertebral area of ossification ('floating osteophyte') is often seen.

- 63 An 8 year old child presents with exquisitely tender hands. Blood films demonstrate a haemolytic anaemia.**

**Which of the following are not plain film manifestations of this condition?**

- (a) H-shaped vertebrae
- (b) Rib notching
- (c) Hair on end appearance of the skull
- (d) Cortical thickening
- (e) Osteoporosis

**63 (d)**

Sickle cell disease is characterised radiologically by marrow hyperplasia. This leads to a decrease in the density of the skull with diploic widening, with widening of the medullary space. There is usually cortical thinning, along with changes related to infarction such as the 'bone-in-bone' appearance or osteonecrosis.

**64 A man with lower back pain has a plain lumbar radiograph. The L5 vertebral body has slipped forward on S1 by 60% of the body diameter.**

**What grade spondylolisthesis does this represent?**

- (a) I
- (b) II
- (c) III
- (d) IV
- (e) V

**64 (c)**

Spondylolisthesis is graded from I-IV with each grade corresponding to 25% of displacement.

**67 A 60 year old man who had a THR a year previously presents with discomfort and a clicking sensation in that hip.**

**Which of the following features are considered normal?**

- (a) 3 mm radiolucent zone at the cement bone interface
- (b) Endosteal sclerosis at the tip of the femoral component
- (c) 5 mm subsidence of the femoral component
- (d) Progressive metal bead shedding
- (e) Cement fracture

**67 (c)**

Serial radiographs are required for full assessment of the joint replacement. As a minimum the British Orthopaedic Association suggest post-operative radiographs, then check radiographs at 1 year, 5 years and every subsequent 5 years. Other signs include progressive radiolucency at the cement bone interface, the presence of well-defined lucencies at the interface which may suggest granulomatous disease and acetabular migration. A degree of subsidence of the femoral component is considered normal and either progressive change or an absolute value of greater than 10 mm is abnormal.

**74 A CT is performed for polytrauma. A Jefferson fracture is suspected.**

**Which of the following appearances is consistent with this diagnosis?**

- (a) Bilateral anterior arch fractures
- (b) Bilateral posterior arch fractures
- (c) Unilateral anterior and posterior arch fractures
- (d) Bilateral fractures of the superior articular facets
- (e) Bilateral transverse process fractures

**74 (c)**

A Jefferson fracture involves both the anterior and posterior arches, and may be either unilateral or (more usually) bilateral.





3) Plain knee radiographs performed in accident and emergency following a sports injury in a 20-year-old footballer show an effusion, a small avulsion fracture immediately proximal to the fibular head, deepening of the lateral femoral sulcus and anterior translocation of the tibia. What is the most likely underlying ligamentous injury?

- a. complete posterior cruciate ligament rupture
- b. complete anterior cruciate ligament rupture
- c. partial anterior cruciate ligament rupture
- d. tibial collateral ligament rupture
- e. fibular collateral ligament rupture

3) b. \*\*

The avulsion fracture described is a Segond fracture, which is classically associated with anterior cruciate ligament (ACL) rupture, and represents avulsion of the meniscotibial portion of the middle third of the lateral capsular ligament. Anterior translocation of the tibia occurs in complete ACL rupture, and manifests clinically as the anterior draw sign. Also associated with ACL rupture is an impaction injury of the lateral femoral condyle, which can be seen on radiographs as a deepened lateral femoral condylar sulcus, although sometimes this cannot be identified on acute films.

4) CT of the cervical spine is performed on an intubated emergency patient who was a restrained driver in a high-speed motor vehicle collision. This reveals bilateral C2 pedicle fractures. What is the most likely underlying mechanism of injury?

- a. hyperflexion and rotation
- b. hyperextension followed by hyperflexion *longitudinal ligament injury*
- c. axial loading *Burst (Jefferson)*
- d. hyperextension and traction *Maignan*
- e. hyper-rotation *soft tissue injury or facet joint dislocation*

4) d. \*\*\*

The fracture described is a hangman fracture. This involves either the pedicles or pars interarticularis of C2 bilaterally. The mechanism is usually extension and traction (as caused during hanging). Hyperflexion injuries produce anterior tear-drop or of a vertebral body wedge fractures. Axial loading can produce a burst fracture of C1 (Jefferson's fracture) or a vertebral body elsewhere in the spine. Hyperflexion and extension are associated with longitudinal ligament injury. Hyper-rotation is associated with soft-tissue injury or facet joint dislocation.

7) A child passenger is admitted to accident and emergency following a road traffic collision. Radiographs of the spine show a horizontal fracture involving the vertebral body and pedicles of L2. Associated injury to which of the following abdominal organs is most likely?

- a. duodenum
- b. pancreas
- c. spleen
- d. liver
- e. rectum

7) a. \*\*\*

The spinal injury described is a **Chance fracture**, a fracture through the vertebral body and pedicles caused by **hyperflexion**, therefore causing compression of the spine anteriorly and distraction posteriorly. This injury typically occurs in back-seat passengers wearing a lap seat belt during a road traffic collision. In children, there is a **50% incidence of associated intra-abdominal organ injury**. **Retroperitoneal organs are most vulnerable, being closest to the spine**. **Duodenal injuries are most common**, and have a significant associated mortality. **The pancreas is also commonly injured due to its retroperitoneal location**.

30) MRI of the knee in an 18-year-old man, performed for pain and limited joint movement, reveals an osteochondral lesion of the medial femoral condyle. Other than displacement, which MRI finding is the most specific indication of an unstable osteochondral fragment?

- a. joint effusion
- b. subfragmental bone resorption
- c. 3 mm cyst deep to the lesion
- d. underlying linear high signal on T2W images
- e. multiple lesions

30) d. \*\*\*

High T2 signal in the bone underlying an osteochondral lesion has been described as the most common of four MRI findings indicating instability of an osteochondral fragment, which is the most important factor when considering treatment options. The reported accuracy of this sign for predicting instability varies from 45% to 85%, with one study reporting an increased accuracy when this sign is combined with the second sign of a cartilaginous defect on T1W images. However, another study states that often only a single indicator is present. The other indicators of instability are high signal in the articular cartilage and a cystic lesion in the bed (but this needs to be 5 mm or larger).

33) A 23-year-old man falls onto his outstretched right hand with his elbow flexed. AP and lateral radiographs of the mid-forearm reveal a fracture of the middle third of the radius. Which additional radiograph should be performed?

- a. clavicle
- b. shoulder
- c. elbow
- d. oblique forearm
- e. wrist

scapulo humeral

33) e. \*\*

A Galeazzi fracture–dislocation is a pattern of injury sustained by falling on an outstretched hand with a flexed elbow. It most commonly consists of a fracture of the radial diaphysis with dislocation or subluxation of the distal radioulnar joint. It is associated with a high rate of non-union, and one or both components are usually treated with surgical fixation. It is important therefore that the radiologist can recognize potential patterns of injury and radiographically demonstrate their full extent. As a general rule, fractures should be viewed in two orthogonal planes, as should the joint above and below any fracture. The opposite pattern, of an ulnar shaft fracture with dislocation of the proximal radial head, is termed a Monteggia fracture–dislocation. A mnemonic for remembering the two is Glasgow Rangers (Galeazzi, radius) and Manchester United (Monteggia, ulna), which indicates for each injury which of the forearm bones is fractured.

34) Which of the following is the most common type of Salter–Harris fracture, accounting for over 70% of growth-plate fractures of the immature skeleton?

- a. type I
- b. type II
- c. type III
- d. type IV
- e. type V



34) b. \*

The Salter–Harris classification originally described five types of growth plate injury. Type I (6–8%) is slip of the epiphysis due to shearing forces, and the fracture line is a cleavage through the growth plate only. Type II is by far the most common (75% of injuries) and is also a shearing injury. The fracture line involves the physis and extends proximally into the metaphysis separating a triangular fragment. Type III (6–8%) occurs in partially closed growth plates, involves the physis and extends distally into the epiphysis, involving the articular surface. Type IV (10–12%) is a fracture that begins in the metaphysis, crosses the physis and also involves the epiphysis. Type V (1%) is a crush injury. The classification indicates progressively poorer prognosis with regard to future growth disturbance. There have been subsequent additions to the classification.

36) A 40-year-old man falls down the stairs and remains unconscious for several hours. On admission to hospital, he is found to have bilateral upper limb weakness, patchy sensory loss, full power in the lower limbs and a normal level of consciousness. Plain radiographs of the cervical spine and CT of the brain are normal. On MRI of the cervical spine, there is a small area of oedema identified within the cord. Clinical symptoms persist for 4 days following injury. What is the most likely diagnosis?

- a. central cord syndrome
- b. anterior cord syndrome
- c. SCIWORA (spinal cord injury without radiological abnormality)
- d. spinal shock
- e. Brown-Séquard syndrome



36) a: \*\*\*\*

In trauma, an incomplete spinal cord injury is one in which there is any degree of sparing of motor or sensory function distal to the site of injury, whereas complete cord injury results in complete lack of neurological function distal to the injury. The diagnosis can be made only in the absence of spinal shock, a transient spinal cord concussion.

Central cord syndrome is the most common incomplete injury, and is associated with hyperextension injury in middle-aged patients; injury to centrally located grey matter in the cord causes a greater motor neurological deficit in the upper than in the lower extremities. Sensory involvement can be variable, and bowel and bladder function may be affected. Anterior cord syndrome, caused by anterior spinal vascular insufficiency, causes complete motor paralysis with sparing of the posterior columns. SCIWORA is seen in children, when the elastic cervical spine deforms sufficiently to cause cord injury but without any radiological findings. Brown-Séquard syndrome results from hemitransection and causes ipsilateral muscle paralysis and contralateral hyperaesthesia to pain and temperature.

39) A young man is assaulted and attends accident and emergency with a painful left mandible and inability to open and close his jaw without pain. Radiographs show a simple linear fracture through the left body in the parasymphyseal region. A second fracture is most likely to be seen at which of the following sites?

- a. ipsilateral condylar neck
- b. ipsilateral angle
- c. symphysis menti
- d. contralateral body
- e. contralateral condylar neck

39) e. \*\*\*

The mandible is best considered as a closed ring, and as such approximately half of all mandibular fractures are bilateral and multiple. The majority occur at the angle, and a significant portion occur at the condylar neck, a common pattern of injury being an ipsilateral body fracture from a direct blow, with a contralateral angle or condylar neck fracture due to transmitted rotation force compressing that side. Fractures of the condylar neck have a limiting effect on the opening and closing of the jaw and can be missed radiographically. Fractures in the midline are also subtle and account for a significant minority. A flail mandible occurs when the anterior support for the tongue is lost due to a bilateral fracture. This injury carries the risk of the tongue prolapsing posteriorly and occluding the airway.

44) Following major trauma, which of the following fractures of the thoracic skeleton is most likely to indicate a significant injury to the underlying intrathoracic viscera?

- a. glenoid
- b. scapular blade
- c. clavicle
- d. first rib
- e. sternum

44) d. \*\*

First rib fracture is considered a harbinger of major trauma, with approximately two-thirds of fractures being associated with major chest injury and carrying a significant mortality. The anatomy of the first rib is such that it is protected from the minor insults that often break other ribs, and fracture of the first rib usually indicates violent blunt trauma to the thorax. Associated local injuries include damage to the brachial plexus, major vascular structures and the underlying lung and heart. There is also an association with significant abdominal injury, but the major cause of death in patients with a first rib fracture is an associated head injury. It is rare for a first rib fracture to be an isolated finding.

45) A young man sustains an obvious head injury during an assault, with clinically apparent, left temporoparietal swelling and an underlying fracture on skull radiographs. The patient's GCS is initially normal but begins to deteriorate progressively after 4 hours of observation, and CT of the brain is requested. Which finding other than a skull fracture would you expect to find on CT to explain the patient's condition?

- a. diffuse axonal injury
- b. haemorrhagic contusions
- c. subarachnoid haemorrhage
- d. subdural haematoma
- e. extradural haematoma or epidural

45) e. \*\*

Extradural (or epidural) haematoma is the accumulation of blood in the potential space between the inner table of the skull and the dura. Ninety per cent of cases are associated with a fracture of the temporal bone which traverses and ruptures the middle meningeal artery (in 60–90%) or vein. In children, vascular injury may occur here without a fracture. In half of cases, there is a lucid interval between injury and the onset of deteriorating consciousness level, as opposed to diffuse axonal injury where coma is immediate. CT appearances are of an extra-axial, biconvex, high-attenuation collection. A subdural haematoma is caused by shearing forces on small bridging veins and is not necessarily associated with a fracture of the calvarium, although this may coexist. It differs from an extradural haematoma not in radiographic location but in that it has a crescentic rather than a biconvex shape.



48) A young male patient sustains an external rotational injury to his left ankle and is unable to bear weight. A plain radiograph of the ankle performed in accident and emergency shows no fracture but does show soft-tissue swelling over the medial malleolus and widening of the ankle joint space medially (lateral talar shift). Which of the following additional view(s) should be performed?

- a. mortise view
- b. calcaneus
- c. foot
- ☒ d. knee *Maisonneuve*
- e. contralateral ankle

48) d. \*\*\*

The **Maisonneuve fracture** is a spiral fracture of the upper third of the fibula associated with a tear of the distal tibiofibular syndesmosis and the interosseous membrane. The medial component of the injury may be an associated fracture of the medial malleolus or rupture of the deep deltoid ligament. The ankle joint is effectively a bony ring that extends up to the knee. Interruption of the ring in this way allows lateral displacement of the fibula and so disruption of the congruence of the ankle mortise, resulting in an unstable ankle injury that requires surgical fixation.

50) O'Donoghue's unhappy triad consists of injuries to which three internal structures of the knee that are commonly injured together?

- a. anterior cruciate and lateral collateral ligaments, medial meniscus
- b. anterior cruciate and lateral collateral ligaments, lateral meniscus
- ☒ c. anterior cruciate and medial collateral ligaments, medial meniscus
- d. anterior cruciate and medial collateral ligaments, lateral meniscus
- e. posterior cruciate ligament, medial and lateral menisci

50) c. \*\*

O'Donoghue's unhappy triad consists of injuries to the anterior cruciate and medial collateral ligaments and the medial meniscus, and is an injury associated with contact sports. The mechanism is indirect trauma

causing deceleration, hyperextension and twisting forces. The combination of external rotation of the tibia on the femur, knee flexion and valgus stress can produce an anterior cruciate ligament injury combined with additional medial collateral ligament injury. The meniscus and collateral ligament medially are attached to one another, unlike their lateral counterparts, resulting in a higher frequency of concordant injury to the other medial structure when one is injured.

52) A young adult male sustains an acetabular fracture in a high-speed road traffic collision. Which type of acetabular fracture is most commonly associated with significant neurological injury?

- a. posterior rim/wall
- b. anterior rim/wall
- c. transverse T-shape
- d. anterior and posterior column
- e. central dislocation



52) a. \*\*

Acetabular fractures are common in multiple or major trauma patients, particularly those involved in road traffic collisions, and are classified according to the Letournel classification. Fractures are often complex and require accurate delineation with CT, often following limited or suboptimal initial radiographic investigation with or without oblique pelvic (Judet) views. Isolated posterior rim or wall fractures are the most common type (27%) and are associated with a high frequency of posterior dislocation of the femoral head causing sciatic nerve injury. If the entire posterior column is involved in the fracture, there is a lower incidence of sciatic nerve injury, as the femoral head may not be dislocated. Anterior injuries are uncommon (5%) and may be associated with anterior femoral head dislocation and iliac wing fracture. Transverse fractures account for 9%.

55) A young adult male sustains an anterior shoulder dislocation while playing rugby. There is no associated fracture. Following apparently uncomplicated reduction in accident and emergency, he is unable to abduct the arm and complains of numbness over the upper lateral arm. What is the most likely cause?

- a. supraspinatus tendon tear
- b. axillary nerve palsy
- c. musculocutaneous nerve palsy
- d. shoulder impingement
- e. deltoid muscle tear

55) b. \*\*\*

The axillary nerve is a large terminal branch of the posterior cord of the brachial plexus that passes into the posterior aspect of the upper arm via the quadrilateral space, where it winds around the surgical neck of the humerus to supply the deltoid and teres minor muscles. It has a cutaneous distribution called the 'regimental badge area' over the lateral aspect of the deltoid (where a soldier may wear his regimental badge). Due to its intimate relationship with the humerus and its passage through the relatively small quadrilateral space, the axillary nerve is by far the most commonly injured nerve with shoulder dislocation or fractures. As loss of abduction may be caused by pain rather than deltoid paralysis, it is good practice to assess the sensation in the cutaneous distribution of the axillary nerve before and after any attempted shoulder reduction.

57) Of the following eponyms associated with fractures, which relates to a fracture-dislocation?

a. Segond

b. Jones

c. Smith

d. Barton

e. Hutchinson Triangular  $\frac{1}{2}$  of radial styloid.

57) d. \*\*

The use of eponymous names for fractures allows quick and accurate identification and communication of bone injuries while simultaneously alerting clinicians to the potential complications associated with a given fracture pattern. This is also particularly useful when describing complex radiographic appearances to someone remote from the images. The full value of such eponyms depends on accurate use and understanding of their meaning: Barton's fracture—dislocation is an intra-articular fracture of the dorsal margin of the distal radius with dorsal dislocation of the radiocarpal joint; Segond's fracture is an avulsion fracture of the proximal lateral tibia; Jones' fracture is a transverse fracture of the base of the fifth metatarsal, at the junction of the diaphysis and metaphysis; Smith's fracture is a distal radial fracture with ventral displacement; and Hutchinson's fracture is a triangular fracture of the radial styloid.

60) Which of the following locations is most often associated with post-traumatic osteolysis?

- a. coronoid process of ulna
- b. surgical neck of humerus
- c. lateral clavicle
- d. femoral neck
- e. fibular head

RA  
other causes  
of osteolysis  
lateral  
clavicle  
scleroderma  
hyperparathyroidism

60) c. \*\*

The lateral third of the clavicle is the most common location for post-traumatic osteolysis. It is usually preceded by a fairly severe injury to the shoulder, typically dislocation or subluxation of the acromioclavicular joint. Changes may be evident radiographically after as little as 1 month. If no bone loss was apparent on radiographs at the time of injury, the diagnosis is unequivocal. However, if no such comparison can be made, then other causes of lateral clavicular osteolysis include rheumatoid arthritis, scleroderma and hyperparathyroidism. Other sites affected are the pubic and ischial rami, distal portions of the radius or ulna, the carpus and femoral neck. Widespread idiopathic osteolysis is termed Gorham's or vanishing bone disease.

- 61) A young man is admitted in cardiac arrest following electrocution. Following successful resuscitation in accident and emergency, he complains of an acutely painful right shoulder with severely decreased range of movement. What is the most likely plain film finding?
- a. anterior shoulder dislocation
  - b. posterior shoulder dislocation
  - c. acromioclavicular dislocation
  - d. fractured surgical neck of humerus
  - e. subacromial impingement

61) b. \*\*\*  
Posterior shoulder dislocation is much rarer than anterior dislocation, accounting for only 5% of dislocations. It can be caused by direct or indirect force and is most commonly seen following seizure or electrocution. The internal rotators of the shoulder are stronger than the external rotators, resulting in internal rotation of the arm if all the shoulder muscles contract simultaneously. This internal rotation predisposes to posterior dislocation in the same way that external rotation does for anterior dislocation. Radiographic findings may be subtle on the AP projection, and include superior position of the humeral head relative to the glenoid, external rotation (the humeral head appears symmetrical like a light bulb), a sharp angle to the scapulohumeral arc and a compression fracture of the anterior humeral head (a reverse Hill-Sachs lesion).



62) A middle-aged woman falls on an outstretched hand, which becomes immediately painful and swollen. A lateral radiograph shows a small fracture fragment dorsal to the carpus, and the AP radiograph appears normal. Which carpal bone is most likely to be fractured?

- a. scaphoid
- b. lunate
- c. triquetrum
- d. capitate
- e. hamate

62) c. \*\*

- Carpal fractures in general are much less common than fractures to the distal radius. The two bones most commonly injured are the scaphoid (75%) followed by the triquetrum (14%), and these provide a

greater diagnostic challenge radiographically than distal radial fractures. Triquetrum fractures generally occur on the dorsal surface due to avulsion of the dorsal radiocarpal ligament, or shearing forces from impaction with the ulnar styloid or hamate in hyperextension. Less commonly, the body of the bone can fracture in a transverse pattern. A posterior chip fragment can often be seen with dorsal surface fractures, but is only visualized on the lateral view. Such an injury may be a primary triquetrum injury (such as avulsion) or related to a perilunate fracture-dislocation.

- 63) An elderly woman falls down the stairs and suffers a Malgaigne fracture of the pelvis and a 1% degloving injury to the left forearm. Due to significant medical co-morbidity, the decision is made not to treat with surgery. The patient dies overnight on the ward. What is the most likely mechanism of death?
- a. pulmonary embolism
  - b. fat embolism
  - c. septicaemia
  - d. myocardial infarction
  - e. intra-abdominal haemorrhage

63) e. \*\*

A Malgaigne fracture of the pelvis is a fracture of the ischiopubic rami and an ipsilateral sacroiliac joint (or para-articular) fracture, and occurs due to high-energy blunt trauma. It represents complete disruption of the pelvic ring and therefore an unstable fracture. In such fractures, distortion and disruption of the pelvic soft tissues and vascular injury involving the rich blood supply in the pelvis will not be tamponaded by the bony ring, as the pelvis will expand to accommodate ever-increasing haematoma. Mortality rate from major pelvic trauma is 10%; other common causes of death include multiorgan failure and sepsis, the latter expected to take several days to evolve.

- 64) A 20-year-old man is a restrained driver in a high-speed road traffic collision. On admission to accident and emergency he undergoes CT of the brain for a reduced consciousness level. Images show diffuse brain injury. Which of the following findings would support a diagnosis of diffuse axonal injury rather than simple contusions?
- a. corticomedullary petechial haematoma
  - b. anterior temporal petechial haematoma
  - c. basofrontal petechial haematoma
  - d. intraventricular haemorrhage
  - e. brain oedema



64) a. \*\*

**Contusions** are traumatic injuries to the cortical grey matter of the brain and make up approximately half of primary intra-axial traumatic lesions. They are often multiple and bilateral, with the most common locations being the inferior frontal lobes and temporal poles. **Diffuse axonal injury** results from rotational shearing forces on cerebral white matter and common locations are white matter-rich areas, such as the corticomedullary junction, centrum semiovale, corpus callosum and cerebellum. In comparison to diffuse axonal injury, contusions tend to be larger and more superficial, with a higher proportion being haemorrhagic due to the increased vascularity of grey compared with white matter. Local or widespread oedema can be seen in both conditions.

67) In reviewing a fracture of the spine at the thoracolumbar junction in a major trauma case, which single indicator on CT is most sensitive for inferring instability?

- a. widened facet joints
- b. two-column malalignment
- c. soft-tissue swelling
- d. rotational abnormality
- e. increased intervertebral disc space

67) b. \*\*

The spine can be divided anatomically into three columns: the anterior column contains the anterior longitudinal ligament, anterior half of the vertebral body and anterior annulus fibrosus; the middle column contains the posterior half of the vertebral body, posterior longitudinal ligament and the posterior annulus fibrosus; and the posterior column contains the posterior elements of the spine, facet joint capsule and interspinous ligaments. Two intact columns are required for intrinsic spinal stability. Disruption of two columns can therefore be used to infer instability. Usual traumatic patterns are anterior and middle, or posterior and middle, disruption. Isolated middle column interruption can occur after trauma or surgery, or as a congenital abnormality, and is also considered potentially unstable.

70) Which of the following local factors is not associated with an increased risk of fracture non-union?

- a. infection
- b. fracture mobility
- c. avascular fragments
- d. impaction
- e. open fracture

70) d. \*\*

Fracture sites that have a poor blood supply, either as a result of the original injury or due to subsequent surgical treatment, may go on to develop atrophic non-union where the bone ends become osteoporotic, thin and pointed (osteolysis) with no evidence of fracture healing. A fracture site that is very mobile may develop hypertrophic non-union where there is attempted healing denoted by excessive callus formation, but the fracture cleft persists. Open fractures are often high energy, with soft-tissue damage and comminution of fracture fragments, and are prone to infection, all of which predispose to non-union. Osteomyelitis in any fracture can result in delayed, non- or malunion. Non-union in most skeletal locations should not be diagnosed radiographically until 6 months have passed, particularly in the presence of complicating factors.

72) The hypoperfusion complex, seen in patients who have suffered major blunt abdominal trauma, includes all but which of the following radiological signs on contrast-enhanced CT?

- a. hyperenhancement of the adrenal glands
- b. hyperenhancement of the pancreas
- c. hyperenhancement of the spleen
- d. collapsed inferior vena cava
- e. small aorta

72) c. \*\*\*\*

The hypoperfusion complex is a marker of severe injury and is an important prognostic indicator related to radiological signs on CT following blunt abdominal trauma. The features are of hypovolaemia, with small arterial and collapsed venous vessels indicating reduced circulating volume. Hyperenhancement of the kidneys, adrenal glands, pancreas and bowel wall is seen, but the spleen may be small and hypodense. If injury to the vascular pedicle is not present, non-enhancement of the spleen could be secondary to severe vasoconstriction and poor perfusion.

74) A middle-aged man has a history of an undiagnosed wrist injury interfering with his playing golf. He presents with clinically apparent ulnar nerve compression at the wrist. Which of the following causes is most likely to be identified following investigation with CT and MRI?

- a. non-union of hook of hamate fracture
- b. non-union of scaphoid wrist fracture
- c. scapholunate dissociation
- d. pisiform osteoarthritis
- e. triangular fibrocartilage complex tear

74) a. \*\*\*\*\*

Fractures of the hook of the hamate are the most frequent type of hamate fracture, and most often occur from the repetitive stress of swinging a bat, club or racket, or from the direct blow of a club on the ground. This may result in ulnar nerve compression at the wrist in Guyon's canal, which is particularly exacerbated in the context of non-union due to secondary osteoarthritis or loose bodies in the pisotriquetral joint. Other causes of ulnar nerve compression at the wrist include adjacent masses, anomalous muscles and tendons, fibrous palmar arch, ulnar artery aneurysm, primary osteoarthritis of the pisotriquetral joint, os hamuli proprium and dislocation of the pisiform bone.



75) A 16-year-old female gymnast sustains a twisting injury to the knee, which becomes immediately painful and swollen, and she is unable to bear weight. Initial radiographs show an effusion but are otherwise normal. MRI confirms a joint effusion with a torn medial retinaculum, marrow oedema affecting the anterior aspect of the lateral femoral condyle, and a chondral defect of the medial facet of the patella. What is the most likely injury?

- a. lateral collateral ligament tear
- b. medial meniscal tear
- c. pivot shift injury
- d. transient patellar dislocation
- e. posterolateral corner syndrome

75) d. \*\*  
Transient patellar dislocation always occurs laterally and was originally thought to be an injury confined to teenage girls with abnormal

patellofemoral anatomy, but is now considered a potential injury in anyone who partakes in athletic activity. The most common finding is effusion and lateralization of the patella with or without an abnormally shallow femoral sulcus. Other findings seen on MRI are contusions of the lateral femoral condyle and medial patella with potential osteochondral defects, and disruption or sprain of the medial retinaculum. Less-specific findings include loose bodies and associated ligamentous or meniscal injury.

- 77) A patient undergoes skull radiographs for a suspected occipital depressed skull fracture after falling backwards onto the pavement. You receive non-angulated AP frontal and lateral views. Which additional view would you request from the radiographer in order to detect an occipital bone skull fracture?
- a. orthopantomogram
  - b. submentovertical
  - c. Towne's
  - d. Caldwell's
  - e. Water's

77) c. \*\*\*

In modern radiology departments with the widespread availability of CT, the indications for skull radiograph are few, and it has little place in the evaluation of brain injury. Standard practice will usually comprise a lateral and a PA frontal view. The frontal view may be angled to show different areas of anatomy. Towne's view is an AP projection through the frontal and occipital bones ( $30^\circ$  caudal tube tilt) and is mainly used to show the occipital bone. The Caldwell view is a similar AP projection but with only  $15^\circ$  of caudal tube tilt to allow evaluation of the orbits. An occipitomental (and therefore PA, unlike Towne's or the Caldwell) projection is called Water's view. It is used to demonstrate the facial bones and sinuses and may be angulated to highlight the zygomatic arches. Further angulation results in a submentovertical view, which is also used to evaluate the zygomatic arches. This requires extension of the neck and is therefore contraindicated in patients with suspected cervical spinal injuries. The orthopantomogram is a panoramic view of

the mandible used primarily in dental radiography and to evaluate the whole of the mandible in a single exposure.

79) A young woman attempts to commit suicide by jumping from a third-storey window, sustaining a fall of 15 metres. In addition to bilateral lower limb and spinal fractures, she suffers a blunt deceleration injury to the mediastinum. CT findings are of a large mediastinal haematoma and a focal area of irregularity in the contour of the wall of the aorta, which appears otherwise normal. Which segment of the thoracic aorta is most commonly affected by tear or transection?

- a. root
- b. ascending
- c. isthmus *crushed by bony thorax (manubrium, clavicle and 1st rib)*
- d. arch
- e. descending

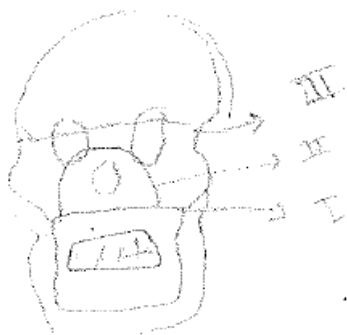
79) c. \*\*\*

Ninety per cent of traumatic thoracic aortic injuries occur at the aortic isthmus, just distal to the origin of the left subclavian artery. The isthmus is the section between the origin of the left subclavian and the attachment of the ligamentum arteriosum, and is about 1.5 cm in length in a normal adult. The mechanism is usually rapid deceleration (but it can be due to direct trauma) as in a fall from a height or a road traffic collision. The isthmus is thought to be particularly vulnerable to the shearing forces that occur with deceleration compared with the descending aorta, as it is relatively mobile and can be bent over the left bronchus main stem and left pulmonary artery. A more recent theory is that this part of the aorta is particularly vulnerable to being crushed by the surrounding bony thorax (manubrium, clavicle and first rib) at the point of maximum deformation during high-energy injury. The ascending aorta is the site for injury in only 5% of those who survive to reach hospital, but is more prevalent in cadaveric studies due to the high association of fatal cardiac injuries. The mechanism here is thought to be torsional forces or a water-hammer effect (a sudden increase in intrathoracic pressure).



89) A young man is admitted to accident and emergency following an assault, during which he was struck in the face with a heavy blunt object. Radiographs show multiple midface fractures. Which supporting buttress of the face is disrupted in a Le Fort II fracture, but spared in a Le Fort I fracture?

- a. inferior lateral maxillary
- b. inferior medial maxillary
- c. superior medial maxillary
- d. transverse maxillary
- e. pterygomaxillary



89) c. \*\*\*\*\*

Le Fort fractures involve separation of all or part of the maxilla from the skull base. For this to occur, the posterior vertical maxillary (pterygomaxillary) buttress at the junction of the posterior maxillary sinus with the pterygoid plates of the sphenoid must be disrupted. The remaining facial buttresses are inspected to determine the class of Le Fort fracture. A Le Fort I fracture involves the inferior portions of both the lateral and medial maxillary buttresses, resulting in the maxillary arch floating free from the face. In a Le Fort II fracture, the inferior lateral maxillary buttress is similarly injured, but, unlike type I, it is associated with fracture of the superior portion of the medial maxillary buttresses, resulting in dissociation of the entire maxilla from the skull base. A Le Fort III fracture results in the whole face floating free from the skull with disruption of the superior portions of both the lateral and medial maxillary buttresses and upper transverse maxillary buttress.

99) A young footballer sustains a twisting injury to the right knee in training. He is able to continue practising but complains of moderate medial knee pain. The following morning he wakes with a swollen stiff joint. Radiographs show an effusion only. Subsequent MRI confirms an effusion and reveals a truncated medial meniscus with a 'bow-tie' configuration seen on only a single sagittal image. Sagittal sequences reveal a 'double' appearance of the posterior cruciate ligament. He has not had any previous surgery. What is the most likely injury or combination of injuries? *Bucket handle*

- a. torn medial meniscus
- b. torn medial meniscus and anterior cruciate ligament
- c. torn medial meniscus and posterior cruciate ligament
- d. torn anterior cruciate ligament
- e. torn posterior cruciate ligament

99) a. \*

Truncation of a meniscus may be due to previous injury or surgical resection, but in the absence of a relevant history it suggests meniscal tear with displacement of the body of the meniscus. On sagittal sequences, one would normally expect to see a full 'bow-tie'-shaped meniscus on three or more contiguous images, as the meniscal body is approximately 11 mm in thickness (this of course will depend on slice thickness). Any fewer suggests a meniscal body tear with displacement of the fragment. The fragment often flips into the intercondylar groove of the femur to lie anterior and parallel to the posterior cruciate ligament, giving the impression of two similar structures. This injury is known as a **bucket-handle tear**.

3. A 56 year old motorcyclist has a trauma series of plain films following a road traffic accident. On evaluation of the lateral cervical spine film, which of the following soft-tissue parameters would be a concerning feature?
- a. Predental space of 3 mm
  - b. Nasopharyngeal space of 7 mm
  - c. Retropharyngeal space of 10 mm
  - d. Retrotracheal space of 20 mm
  - e. Decreased disc space at the C5/6 level

### 3. c. Retropharyngeal space of 10 mm

This is too wide for the retropharyngeal space. The correct acceptable limits for soft-tissue measurements are as follows:

- Predental space 3 mm in adults, 5 mm in children.
- Nasopharyngeal space (anterior to C1) 10 mm.
- Retropharyngeal space (C2–C4) 5–7 mm.
- Retrotracheal space (C5–C7) 22 mm.

Disc spaces should be roughly equal throughout the cervical spine. Narrowing of a disc space is usually due to degenerative change, but widening would be a more concerning feature.

5. In a 65 year old woman with a fracture of the neck of the humerus, which of the following classification systems to describe the fracture would be useful in guiding the surgical management?
- a. Garden classification
  - b. Neer classification
  - c. Weber classification
  - d. Fryman system
  - e. Crosby–Fitzgibbon system

### 5. b. Neer classification

The Neer classification system is used to grade humeral neck fractures. This system describes four parts – greater tuberosity, lesser tuberosity, humeral head and shaft of humerus. According to Neer, a fracture is displaced if there is more than 1 cm of displacement and 45° angulation between any two segments. Two-part fractures involve any of the four parts and include one fragment that is displaced. Three-part fractures include a displaced fracture of the surgical neck in addition to either a displaced greater tuberosity or lesser tuberosity fracture. Four-part fractures include displaced fractures of the surgical neck and both tuberosities.

9. A young man presents to A&E following a fall onto his outstretched right arm. Plain films of the right forearm show a fracture of the distal forearm with volar angulation of the distal fragment with no intra-articular component. The carpal bones remain well aligned. Which of the following injuries has he sustained?
- a. Smith's fracture
  - b. Barton's fracture
  - c. Monteggia fracture
  - d. Galeazzi fracture
  - e. Colles fracture

**9. a. Smith's fracture**

This description is of a Smith's fracture. More common is a Colles fracture, which is a fracture of the distal radius with dorsal angulation of the distal fragment. A Monteggia fracture is fracture of the ulnar with dislocation of the radial head. A Galeazzi fracture is a fracture of the radius with dislocation of the distal ulnar. Barton's fracture is a fracture of the distal radius with dislocation of the distal radiocarpal joint.

10. A 24 year old man injured his left knee whilst skiing. He presents with pain and swelling over the lateral aspect of the knee joint. AP plain radiographs demonstrate an avulsion fracture of the lateral aspect of the proximal tibia below the articular surface. A joint effusion is also seen. The most likely associated ligamentous injury is to which of the following structures?
- a. Posterior cruciate ligament
  - b. Anterior cruciate ligament
  - c. Medial collateral ligament
  - d. Lateral collateral ligament
  - e. Ligament of Humphry

**10. b. Anterior cruciate ligament**

The fracture described is a Segond fracture, originally documented by Dr Paul Segond in 1879 after a series of cadaveric experiments. The Segond fracture occurs most commonly in association with anterior cruciate ligament injuries (75–100%) and medial meniscal injuries. Due to the high rate of associated injuries, a patient who sustains a Segond fracture will require further imaging, usually by way of MRI, in order to specifically investigate the ligaments and menisci.

12. A 32 year old footballer sustains an avulsion injury to the anterior superior iliac spine during training. Which of the following muscles is likely to be affected?
- Sartorius
  - Gracilis
  - Iliopsoas
  - Rectus femoris
  - Semimembranosus

12. a. Sartorius

Sartorius has its origin at the anterior superior iliac spine and inserts into the pes anserinus. A sartorius muscle injury can therefore cause an avulsion fracture of the anterior superior iliac spine. Gracilis has its origin at the inferior pubic ramus, and rectus femoris has its origin at the anterior inferior iliac spine.

15. A 24 year old rugby player attends A&E following a tackle during which he felt his left shoulder dislocate. Initial plain radiographs confirm an anterior inferior dislocation of the left shoulder. Which of the following statements is true?
- The humeral head lies inferior and lateral to the glenoid on the AP view
  - The presence of a Hill-Sachs defect indicates previous dislocation
  - Hill-Sachs lesions are more common than Bankart lesions
  - Anterior dislocation accounts for 50% of shoulder dislocations
  - A Hill-Sachs lesion affects the inferior aspect of the humeral head

15. c. Hill-Sachs lesions are more common than Bankart lesions

A Hill-Sachs lesion affects the postero-superior aspect of the humeral head and whilst it does often indicate a previous dislocation, this is not necessarily the case and it can be present after a single episode. A Bankart lesion affects the inferior glenoid. Almost 95% of all shoulder dislocations are anterior.

18. A 23 year old man sustains a Jefferson fracture to his cervical spine following an injury in which he dived into a shallow swimming pool, hitting his head on the bottom. Which of the following regarding his injury is incorrect?
- Displacement of the lateral masses of C1 relative to the dens on an odontoid view indicates a transverse ligament rupture
  - Associated C2 fracture will be present in up to 30% of cases
  - Jefferson fractures are usually associated with a neurological deficit
  - Up to 50% are associated with a further cervical spine injury
  - There may be associated vertebral artery injury



18. **c. Jefferson fractures are usually associated with a neurological deficit**

Jefferson fractures are not usually associated with neurological deficit. Although there may be retropulsion of fragments into the vertebral canal, spinal cord injury is rare due to the large dimensions of the canal at this level. Vertebral artery injury, however, must be considered and if there is concern either CTA or MRA imaging should be considered.

24. A 28 year old man is brought into the emergency department following an assault during which he was stabbed in the left flank. He has a 1.3 cm wound just below the left costal margin in the mid-axillary line. No information regarding the knife has been obtained. His renal function is within normal limits and he has no contrast allergies. The optimal CT protocol for scanning his abdomen would include the following contrast:

- a. IV contrast only
- b. Oral contrast and rectal contrast
- c. IV contrast and oral contrast
- d. Oral, rectal and IV contrast
- e. IV contrast and rectal contrast

24. **d. Oral, rectal and IV contrast**

A triple contrast technique has been advocated in penetrating trauma where there may be concern regarding small bowel or colon trauma. If no oral or rectal contrast are given then a small bowel or colon injury can easily be missed.

25. A 75 year old man who is on warfarin for atrial fibrillation is involved in a high-speed road traffic accident in which he sustains a head injury. He lost consciousness at the scene. On arrival at the A&E department his GCS is 15. He has no other obvious injuries. According to NICE guidelines, his management should include the following:

- a. Skull radiograph
- b. No immediate imaging but admission for regular neurological observations
- c. CT head
- d. Skull radiograph followed by CT head
- e. MRI head

25. **c. CT head**

According to NICE guidance he should undergo CT head and the investigation should be performed within the hour following referral. The fact he is anticoagulated, over 65 and experienced a loss of consciousness would all be factors in warranting an urgent CT head.

34. A 25 year old male is involved in a 60 mph road traffic accident with a head-on collision. He was wearing a seat-belt but his car did not have an air-bag. A screening lateral radiograph of the cervical spine shows the following findings: an angular kyphosis centred at C4/C5, a 1 mm anterior slip of C4 on C5, and widening of the interspinous space posteriorly. What is the likely mechanism for this injury?
- a. Lateral compression
  - b. Flexion
  - c. Extension
  - d. Combination
  - e. Rotation

**34. b. Flexion**

This describes the typical appearance for a flexion injury as well as the typical mechanism. This would represent a potentially unstable fracture and immobilisation would be essential until further management decisions are made. Flexion teardrop injuries are more common in the lower cervical spine and extension teardrop injuries are more common in the upper cervical spine.

- 36) A 56 year old woman slips off the pavement onto the road and her outstretched foot is run over by a passing car. She has immediate severe midfoot pain. Plain radiographs taken on arrival at the emergency department confirm a Lisfranc fracture dislocation of the midfoot. Which two bones does the Lisfranc ligament attach to?
- a. First metatarsal and intermediate cuneiform
  - b. First metatarsal and medial cuneiform
  - c. Second metatarsal and medial cuneiform
  - d. Second metatarsal and intermediate cuneiform
  - e. First and second metatarsals to the medial and intermediate cuneiforms

**36. c. Second metatarsal and medial cuneiform**

The Lisfranc ligament attaches between the second metatarsal and medial cuneiform, which is why an injury to this ligament allows the second to fifth metatarsals to drift laterally once they have lost this stabilisation. This is therefore an unstable injury and requires rapid immobilisation. This is a vital injury to detect as long-term sequelae will often result from a delayed diagnosis.

43. A 27 year old man who attends A&E following an alleged assault is shown to have a left-sided longitudinal temporal bone fracture. Which of the following is a correct association?
- a. Facial nerve palsy in 50% of cases
  - b. Incudostapedial joint dislocation
  - c. Sensorineural hearing loss
  - d. Ophthalmoplegia
  - e. Rhinorrhoea

**43. b. Incudostapedial joint dislocation**

Longitudinal fractures of the temporal bone are more common than transverse fractures and account for over 85% of temporal bone fractures. They are associated with otorrhea, conductive hearing loss, pneumocephalus, herniation of the temporal lobe and incudostapedial dislocation. Transverse fractures are associated with sensorineural hearing loss, and a higher percentage of facial nerve palsies.

48. Regarding scaphoid fractures, which of the following statements is correct?
- a. 80% of scaphoid fractures occur at the waist
  - b. Approximately 5% of scaphoid fractures are complicated by avascular necrosis
  - c. Injury is typically due to hyperextension
  - d. Up to 60% of scaphoid fractures cannot be seen on initial radiograph
  - e. The specificity of CT in diagnosing scaphoid fractures is 60–70%

**48. c. Injury is typically due to hyperextension**

The scaphoid bone is the most commonly fractured carpal bone and the mechanism is usually a fall onto the outstretched hand – ie. hyperextension of the wrist. The reported sensitivities and specificities of CT are 89–97% and 85–100%, respectively. The high negative predictive value of CT (96.8–99%) makes it very useful for ruling out a fracture. Scaphoid fractures are missed on initial radiographs in up to 30% of cases.

49. A 24 year old man is involved in a road traffic accident. On arrival in A&E he is haemodynamically unstable and there is concern regarding pelvic fracture and associated active extravasation. On multidetector CT, which of the following features is more suggestive of pseudoaneurysm than active extravasation?
- a. Ill-defined area of high attenuation on arterial phase imaging
  - b. Presence of a haemoperitoneum
  - c. Washout of the high-attenuation area on delayed imaging
  - d. Layering appearance on delayed imaging
  - e. Haemodynamically unstable patient

**49. c. Washout of the high-attenuation area on delayed imaging**

Washout of the high-attenuation area is one of the features of a pseudoaneurysm. A pseudoaneurysm is likely to be adjacent to a vessel and whilst there will be a relatively well-defined area of high attenuation on arterial phase imaging, this will diminish in intensity on five-minute delayed imaging. In contrast to this, an area of active extravasation will often appear as a jet of high attenuation which continues to collect and enlarge on delayed phase imaging.

50. A 27 year old woman is brought into A&E following a road traffic accident in which she was knocked down by a car. On arrival she has a GCS of 15 but is haemodynamically unstable and on examination she has abdominal bruising. The A&E consultant has performed a FAST (focused assessment with sonography in trauma) scan in resus and cannot see evidence of free fluid. What is the approximate minimal detectable fluid volume by FAST scanning?
- a. 10 ml
  - b. 50 ml
  - c. 100 ml
  - d. 200 ml
  - e. 500 ml

**50. d. 200 ml**

The approximate minimal detectable fluid volume is 200 ml. The distribution of free fluid will be determined by both anatomical and physiologic factors and therefore the sensitivity of the scan will depend upon the areas scanned. Ultrasound is often used in conjunction with multidetector CT, particularly in the management of patients who have been involved in trauma.

51. An A&E SHO has asked you to review a paediatric cervical spine plain film which has been performed on a child who has been involved in a road traffic accident. He is unsure as to whether or not the appearances are normal for a paediatric cervical spine film. Which of the following findings is more likely to represent a true cervical spine injury than a normal variant?
- a. Absence of usual cervical lordosis
  - b. Widening of the prevertebral soft tissues in expiration
  - c. Increased distance between the tips of the C1 and C2 spinous processes in flexion
  - d. Wedging of the anterior aspect of the C3 vertebral body
  - e. A 7 mm gap between the occipital condyles and the condylar surface of the atlas

51. e. **A 7 mm gap between the occipital condyles and the condylar surface of the atlas**  
This is highly suggestive of craniocervical injury; these injuries are often fatal and are often caused by sudden deceleration. Radiologic evaluation of this injury can be difficult but is crucial in determining further management. The remainder of the findings above can all be

normal variants in the paediatric cervical spine and therefore should be interpreted with care.

52. A 24 year old man has injured his right ankle playing football. The A&E SHO has asked your opinion on the plain radiographs. These show a widening of the medial joint space on the AP ankle view but no evidence of fracture, and an oblique fracture of the proximal shaft of the fibula. This is the typical appearance for which of the following fractures?
- a. Weber B
  - b. Maisonneuve
  - c. Pilon
  - d. Dupuytren's
  - e. Fibula stress fracture

52. b. **Maisonneuve**

This is the description of a Maisonneuve fracture (sometimes classified as Weber C3). This injury is often overlooked as the patient may complain only of ankle pain and hence a full tibia/fibula plain film is not taken. This fracture is often associated with ligamentous injury at the ankle, most usually of the anterior talofibular ligament and the postero-inferior talofibular ligament.



60. A 27 year old man falls onto his right hand during a game of rugby. He attends the A&E department and a plain film of the right hand shows a comminuted fracture through the base of the thumb metacarpal with an intra-articular component. This is the description of which of the following fractures?
- a. Rolando's fracture
  - b. Bennett's fracture
  - c. Gamekeeper's thumb
  - d. Boxer's fracture
  - e. Barton's fracture

60. a. Rolando's fracture

This is the classic description of a Rolando's fracture. A Bennett's fracture is also a fracture of the base of the first metacarpal but with no comminution; this fracture is often less stable than a Rolando's fracture and more often requires surgical fixation. A 'gamekeeper's thumb' often occurs as the result of forced abduction of the thumb and results in disruption of the ulnar collateral ligament.

- 23 A 73-year-old man sustained a ureteric injury during a road traffic accident and is now haemodynamically unstable. What is the most appropriate radiological investigation in the acute setting?
- a Contrast-enhanced CT
  - b Unenhanced CT
  - c Retrograde urethrography
  - d One-shot IVU following intravenous contrast medium administration
  - e Trans-rectal ultrasound (TRUS) of prostate to look for damage to prostatic urethra

- 23 Answer D: One-shot IVU following intravenous contrast medium administration

In an unstable patient, there is no time for a CT scan, and a 'one-shot' IVU would be the simplest and most effective study prior to potential surgery. CT remains the investigation of choice in any blunt abdominal trauma in a stable patient.

- 25 A 20-year old man jumped 30 feet from a building onto concrete and landed on his feet. He was assessed in the Emergency Department and complained only of severe pain in his feet. He remained haemodynamically stable and after a full assessment it is clear that his only injuries are to his feet. What injury is he most likely to have sustained?
- a Osteochondral fracture of talar dome
  - b March fractures of second and third metatarsals
  - c Comminuted calcaneal fractures
  - d Maisonneuve fracture
  - e Transverse fracture of fifth metatarsal

25 Answer C: Comminuted calcaneal fractures

Predictable patterns of injury after a fall from a height include: calcaneal, pelvic and thoraco-lumbar spine fractures. A Maisonneuve fracture is a proximal fibular fracture commonly associated with a medial malleolar avulsion fracture.

- 26 A 46-year-old woman is brought into the emergency room after a road traffic accident. She was the driver and had a high-speed collision with a parked van. She responds to pain and is haemodynamically stable. There are no obvious bony or visceral injuries on either primary or secondary survey. She has had an urgent CT head, which revealed no abnormality and her C-spine is clear. As the on-call radiologist you are asked to review her chest X-ray, which shows a widened mediastinum. There are no previous studies available for comparison. What should the subsequent radiological management be?
- a Transthoracic echocardiography
  - b Cardiac MRI
  - c Lateral chest X-ray
  - d Contrast-enhanced CT chest
  - e No imaging, transfer directly to theatre for thoracotomy

26 Answer D: Contrast-enhanced CT chest

A widened mediastinum is sensitive, but not specific for blunt aortic injury. Accordingly, contrast-enhanced CT (or trans-oesophageal echocardiography) should be performed to exclude aortic injury.

- 28 A woman with poorly controlled diabetes mellitus fell down the stairs feet first. She did not experience much pain but found it difficult to walk after the fall and visited the Emergency Department where a doctor noticed that her ankle joint appeared abnormal with a large haematoma on the medial aspect of her foot. Neurological examination demonstrated bilateral sensory impairment in a stocking distribution. What injury is she most likely to have sustained?
- a Osteochondral fracture of the talar dome
  - b Fracture of the medial malleolus
  - c Maisonneuve fracture
  - d Lisfranc fracture-dislocation
  - e Pilon fracture

28 Answer D: Lisfranc fracture-dislocation

A fracture of the first or second metatarsal in conjunction with a dislocation of the tarso-metatarsal articulation is termed a Lisfranc fracture-dislocation. Such injuries usually require a significant force. A fracture of the medial malleolus usually occurs as a result of an inversion injury. A fracture of the proximal fibula (with disruption of the proximal talofibular syndesmosis) in conjunction with a fracture of the medial malleolus is termed a Maisonneuve fracture. Diabetics are at risk of peripheral neuropathy and subsequent injury due to lack of sensation and the commonest cause of a Charcot joint in the Western world is diabetes.

- 29 A 44-year-old man had an accident in which he was thrown from a motorcycle. He landed on his left foot, which folded beneath him. On the day of the injury, his foot was examined and standard AP and lateral radiographs revealed no fracture. The foot was placed in slight plantar flexion and immobilised with a cast. After three days, the patient was re-evaluated and his foot remained oedematous. Ecchymoses was noted laterally and he could not weight-bear. What injury is he most likely to have sustained?
- a No bony or ligamentous injury is likely
  - b Torn ligament between the second metatarsal and medial cuneiform
  - c Transverse fracture through base of fifth metatarsal
  - d Fracture of second metacarpal associated with dislocation of the tarsometatarsal joint
  - e Fracture of medial malleolus

- 29 Answer B: Torn ligament between the second metatarsal and medial cuneiform

An injury to the Lisfranc joint most commonly occurs at the joint involving the first and second metatarsals and the medial cuneiform. The Lisfranc ligament is the only ligament connecting the second metatarsal to the medial cuneiform and may be torn with a Lisfranc injury. While transverse ligaments connect the bases of the lateral four metatarsals, no transverse ligament exists between the first and second metatarsal bases. The joint capsule and Lisfranc ligament form the only minimal support on the dorsal surface of the Lisfranc joint. As many as 20% of Lisfranc joint injuries are missed on initial anteroposterior and oblique radiographs.

- 31 A 26-year-old woman suffered an assault in which she sustained a blow to the right side of her chin. She was unable to close her mouth fully and her incisors were chipped. An orthopantomograph (OPG) examination revealed a mandibular fracture. At what anatomical site is the fracture most likely?
- a Mandibular condyle
  - b Ramus of mandible
  - c Coronoid process of mandible
  - d Parasymphyseal
  - e Body of mandible

- 31 Answer A: Mandibular condyle

The site of mandibular fractures in order of frequency: condyle (30%), angle (25%), symphysis/parasymphysis (22%), body (16%), dentoalveolar ligament (3%), ramus (2%), coronoid process (1%).

- 33 A football goalkeeper dived to the ground while making a save and experienced immediate pain in his wrist. The action replay shows forced hyperextension in ulnar deviation. Radiographs reveal no abnormality on the AP projection, but a subtle fracture on the lateral view. What bone is most likely to have been injured?
- a Capitate
  - b Hamate
  - c Lunate
  - d Pisiform
  - e Triquetral

33 Answer E: Triquetral

Triquetral fractures are common although easily missed on standard frontal projections. On a lateral projection an avulsed flake of bone lying posterior to the triquetral is typical. The usual mechanism of injury is falling onto an outstretched hand in ulnar deviation. A less common mechanism of triquetral fracture is a direct blow to the dorsum of the hand, which would usually be accompanied by other carpal fractures as a greater force is required. A fall onto an outstretched hand more commonly causes a scaphoid fracture although this is more likely in radial rather than ulnar deviation.

- 34 A skier fell on his outstretched hand with his hand caught in his ski pole and sustained an abduction injury of his thumb. His thumb was painful and swollen and he noticed that it felt unstable. He consulted a doctor in the resort who arranged radiographs of his hand and wrist. What is the most likely diagnosis?
- a Dislocation of carpo-metacarpal joint of thumb
  - b Soft-tissue injury only
  - c Scaphoid fracture
  - d Rupture of ulnar collateral ligament
  - e Dislocation of first metacarpophalangeal joint



**34 Answer D: Rupture of ulnar collateral ligament**

Chronic injury of this ligament is termed 'gamekeeper's thumb' but the acute form is now much more common and is termed 'skier's thumb' due to acute forceful abduction of the thumb usually when trapped in a ski pole. The ulnar collateral ligament originates from the first metacarpal head and may avulse a small fragment of bone from its proximal phalangeal insertion. Subluxation, but not usually frank dislocation, of this joint is seen and prompt consideration of surgical repair is indicated to prevent prolonged pain and functional impairment.

- 35** A 47-year-old woman sustained a significant flexion injury to the cervical spine as a result of a high-velocity road traffic accident. Her spine was immobilised and she was taken to the local trauma centre for assessment. A lateral cervical spine radiograph revealed 50% anterolisthesis of C4 on C5 and malalignment of the apophyseal joints. There was no suggestion of a rotational component to the injury. What type of injury is this?
- a Stable unilateral facet dislocation
  - b Unstable unilateral facet dislocation
  - c Bilateral facet dislocation
  - d Jefferson fracture
  - e Perched facets

**35 Answer C: Bilateral facet dislocation**

This injury is inherently unstable, in contrast to unilateral facet dislocation. Severe flexion forces in combination with distraction result in complete disruption of the facet joints and displacement of the vertebral body by at least 50% relative to the one below it. A significant number are associated with traumatic disc herniation. Initial closed reduction and traction is required, but should be done judiciously as it is possible for a disc herniation to retropulse into the cervical canal.

- 22 A 22-year-old man who was an unrestrained back-seat passenger was involved in a high-speed road traffic accident and sustained an aortic injury. Which part of his aorta is most likely to have been injured?
- a Aortic root
  - b Ascending aorta just before origin of brachiocephalic artery
  - c Between brachiocephalic and left common carotid arteries
  - d Just distal to left subclavian artery
  - e Aortic hiatus (level of diaphragm)

22 Answer D: Just distal to left subclavian artery

Rapid deceleration is the usual cause of aortic rupture and this usually occurs just distal to the origin of the great vessels.

- 23 A 25-year-old motorcyclist who was in collision with a bus is being treated for a pelvic fracture and haematuria. On examination he has perineal ecchymoses. He is due to have a CT for further assessment of his urinary tract. How long after injection of 100 mL of low osmolar iodinated contrast at 3.5 mL/second into the antecubital fossa should images be acquired?
- a Immediately
  - b 25 seconds
  - c 60 seconds
  - d 4 minutes
  - e 30 minutes

23 Answer D: 4 minutes

The aim is to acquire the images once contrast has reached the bladder and of the options available 4 minutes is the best choice.

- 25 A young girl dived into a shallow swimming pool and struck the bottom of the pool head first. She was brought to the Emergency Department where she was drowsy and on examination there was a large scalp haematoma and some upper cervical spine tenderness. Which of the following would be the most appropriate imaging?
- a CT head and lateral C-spine radiograph
  - b Skull radiograph and MRI of neck
  - c CT head and AP C-spine radiograph
  - d Skull, AP and lateral C-spine radiographs
  - e CT head and cervical spine

25 Answer E: CT head and cervical spine

Multidetector CT with coronal and sagittal reformatting is now commonplace and the gold standard for cervical spine trauma.

- 26 A 17-year-old teenager was involved in a fight and presented to the Emergency Department with a severely bruised and swollen hand. What fracture is he most likely to have sustained?
- a Fracture of the shaft of the fifth metacarpal
  - b Intra-articular fracture of the base of the first metacarpal
  - c Fracture of the scaphoid waist
  - d Rolando fracture
  - e Triquetral fracture

26 Answer A: Fracture of the shaft of the fifth metacarpal

This is often termed a 'boxer's fracture'. A Bennett's fracture is an intra-articular fracture-dislocation of the base of the thumb metacarpal and Rolando fractures are intra-articular comminuted fractures of the base of the thumb metacarpal.

- 28 A 15-year-old schoolboy suffered an assault with a baseball bat. He was taken by ambulance to the Emergency Department where he was initially fully conscious but subsequently became comatose. After assessment with CT, a neurosurgical intervention produced an excellent recovery. What is the most likely appearance on the CT?
- a Small high-attenuation foci throughout the cerebral cortices
  - b Hydrocephalus
  - c A bi-convex collection of high density adjacent to a linear lucency in the skull vault
  - d A crescentic extra-axial collection of mixed attenuation
  - e A low attenuation collection in the right occipital region with an area of high attenuation in the left frontal region

- 28 Answer C: A bi-convex collection of high density adjacent to a linear lucency in the skull vault

The history is classical for an extra-dural haematoma in which a lucent interval may precede rapid deterioration and prompt neurosurgical evacuation is curative. The haemorrhage is frequently secondary to middle meningeal artery rupture, classically associated with a fracture at the pterion. Small high-attenuation foci (contusions) would be unlikely with the given history and are generally managed conservatively. A crescentic mixed-attenuation collection would be more likely to represent an organising subdural haematoma.

- 29 A 64-year-old man was involved in a high-speed road traffic accident. He had been wearing a seatbelt and there was no evidence of external injury, but he arrived at the local Trauma Centre in haemodynamic shock. His abdomen became tense and distended and there was a profound acidosis on arterial blood gas analysis. A CT scan was performed and a bowel/mesenteric injury was suspected. What findings on CT are most sensitive for surgically important bowel or mesenteric injury?
- a Mesenteric vessel extravasation
  - b Mesenteric air
  - c Intraperitoneal free fluid
  - d Abnormal bowel wall enhancement
  - e Focal mesenteric haematoma

**29 Answer C: Intraperitoneal free fluid**

In a recent study, intraperitoneal free fluid had 100% sensitivity for surgically important bowel or mesenteric injury in the context of blunt abdominal trauma. (although the specificity was only 26% in this context). Other signs are much less sensitive but are much more specific, e.g. abrupt mesenteric vessel termination (sensitivity 45%, specificity 93%) or mesenteric vessel beading (sensitivity 50%, specificity 95%).

**30 A 44-year-old taxi driver was involved in a 40-mph collision with a stationary car. After assessment he was found to have a stable fracture of his cervical spine and was discharged from hospital. What injury is he most likely to have sustained?**

- a Posterior arch fracture of the atlas
- b Flexion teardrop fracture
- c Chance fracture
- d Clay-shoveller's fracture
- e Bilateral interfacetal dislocation of C3/4

**30 Answer D: Clay-shoveller's fracture**

A clay shoveller's fracture is a stable fracture of a lower cervical vertebra spinous process, usually C7. The mechanism is sudden flexion of the neck combined with a heavy upper body and lower neck muscular contraction. This causes avulsion of the spinous process by the supraspinous ligament. A similar fracture may also occur with direct blows to the spinous process or with occipital trauma causing forced flexion of the neck. The remaining fractures are all potentially unstable.

**31 A footballer was tackled from behind while playing in his local park. He felt a sudden 'pop' and his knee became swollen and unstable. While waiting for an MRI scan he noticed his leg pivoted outward about his knee as he walked. What are the most likely findings on the MRI scan?**

- a MCL rupture due to valgus stress
- b LCL rupture due to direct blow
- c MCL rupture due to varus stress
- d LCL rupture due to varus stress
- e MCL rupture due direct blow



31 Answer A: MCL rupture due to valgus stress

Isolated medial collateral ligament (MCL) injuries usually result from a valgus stress without a rotary component. They are more commonly associated with other injuries (e.g. ACL and medial meniscal tears) but isolated MCL tears are sometimes seen.

34 A 17-year-old girl attempted suicide by jumping from the second floor of her apartment building. She landed such that her left leg sustained almost all the impact of her fall. When seen in the Emergency Department she was fully alert, having sustained no head, chest, spinal or abdominal injuries. Her left leg was severely bruised with an open wound and the right leg and foot appeared normal. Radiographs revealed a comminuted distal tibial fracture with intra-articular involvement associated with a fracture of the mid-shaft of the left fibula. What type of injury is this?

- a Maisonneuve fracture
- b Torus fracture
- c Osteochondral fracture
- d Pilon fracture
- e Lisfranc fracture

34 Answer D: Pilon fracture

A high-energy impact where the talus is driven into the tibia can result in a Pilon fracture. Alternatively, a fall from a height may lead to another pattern of injuries such as a comminuted fracture of the calcaneum or fractures of the pelvis or lumbar spine. A multiplanar CT examination is useful for operative planning to show the extent of the fracture.

- 35 A 25-year-old man suffered a severe blow to the side of his face during an assault. He was unable to open his mouth and severe bruising with flattening of the contour of his cheek was visible on initial presentation to hospital. Facial radiographs were performed and a facial fracture was visible that was most clearly seen on the submentovertex view. What is the most likely diagnosis?
- a Zygomatic arch fracture
  - b Le Fort I fracture
  - c Le Fort III fracture
  - d Coronoid process fracture
  - e Orbital blowout fracture

35 Answer A: Zygomatic arch fracture

Zygomatic arch fractures usually result from a direct blow to the side of the face and the classical presentation is with flattening of the cheek and an inability to open the mouth due to impingement of the fracture fragment upon the coronoid process of the mandible or the temporalis muscle. Multiplanar CT is usually indicated although the best radiographic view is the SMV projection if CT is not available.

- 22 A 65-year-old lady sustained an injury to her left loin by falling down a flight of stairs. She had a short hypotensive episode but responded well to IV fluids. She was noted to have bruising and severe pain in her loin extending to her back and a urine dipstick showed the presence of microscopic haematuria. What would be the best investigation?
- a Observation, no imaging required at present
  - b Intravenous urogram
  - c Contrast-enhanced CT
  - d Ultrasound
  - e Renal angiogram

22 Answer C: Contrast-enhanced CT

Multidetector CT imaging is the gold standard for diagnosing and assessing the extent of renal injury, peri-renal haemorrhage, extravasation of urine, pedicle injury, and associated solid-organ injury. Indications include blunt trauma with (macroscopic or microscopic) haematuria and hypotension, polytrauma, rapid deceleration and penetrating injury.

- 23 A 32-year-old motorcyclist presented with blood at the urethral meatus. What is the most effective examination to exclude urethral trauma?
- a Multi detector CT
  - b Pelvic angiography
  - c MRI
  - d Retrograde urethrography
  - e Ultrasound

23 Answer E: Retrograde urethrography

Retrograde urethrography is still widely advocated for excluding urethral trauma. Advanced trauma and life-support guidelines consider any of the following as indicators of possible urethral injury: 1 blood at the urethral meatus; 2 perineal ecchymoses; 3 blood in the scrotum; 4 inability to void; 5 elevation of the prostate on digital rectal examination; 6 pelvic fracture.

- 24 A young girl attended the Emergency Department after tripping over and falling onto her outstretched hand. Clinical examination revealed bruising and swelling on the palmar surface of her hand and she was exquisitely tender in the 'anatomical snuff box'. What would be the best investigation to exclude a scaphoid fracture?
- a Immediate plain radiography including scaphoid views
  - b Plain radiography including scaphoid views after 10 days
  - c Bone scan within 24 hours
  - d MRI within 24 hours
  - e Unenhanced CT

24 Answer D: MRI within 24 hours

There is still some controversy over whether MRI or scintigraphy are the most sensitive modalities for scaphoid fracture detection, but most authorities would accept that imaging within 24 hours is optimal and scintigraphy is most sensitive at 4–5 days post-injury.

- 25 An elderly man on warfarin treatment for atrial fibrillation is found at the bottom of a flight of 10 stairs with widespread bruising to his arms and face. On transfer to the Emergency Department he was confused but is otherwise neurologically intact, moving all four limbs and opening his eyes spontaneously. What is the most appropriate investigation?
- a Carotid Doppler
  - b Urgent CT head
  - c Echocardiogram
  - d Chest X-ray
  - e Skull X-ray

25 Answer B: CT head

There is no scope for a skull X-ray in head trauma. An urgent CT head is mandatory and can delineate fractures and acute haemorrhage very well.

National Institute for Clinical Excellence. *Investigation for Clinically Important Brain Injury: NICE guideline 56*. London: NIHCe; 2007. [www.nice.org/guidance/CG056](http://www.nice.org/guidance/CG056)

Selection of adults for CT scan: urgent scan if any of the following (results within 1 hour)

- GCS<13 when first assessed or GCS<15 two hours after injury
- Suspected open or depressed skull fracture
- Signs of base of skull fracture
- Post-traumatic seizure
- Focal neurological deficit
- >1 episode of vomiting
- Coagulopathy + any amnesia or LOC since injury

A CT scan is also recommended (within eight hours of injury) if there is either more than 30 minutes of amnesia of events before impact or any amnesia or LOC since injury if one of the following applies: Aged  $\geq 65$  years, coagulopathy or on warfarin or a dangerous mechanism of injury (i.e. RTA as pedestrian, RTA – ejected from car, fall >1 m or >5 stairs).

Selection of children (under 16 years) for CT scan: urgent scan if any of the following:

- witnessed loss of consciousness >5 minutes
- amnesia (antegrade or retrograde) >5 minutes
- Abnormal drowsiness
- $\geq 3$  Discrete episodes of vomiting
- clinical suspicion of NAI
- post-traumatic seizure (no PMH epilepsy)
- GCS <14 in emergency room
- (paediatric GCS <15 if aged <1)
- suspected open or depressed skull fracture or tense fontanelle
- signs of base of skull fracture
- focal neurological deficit
- aged <1 – bruise, swelling or laceration on head >5 cm
- dangerous mechanism of injury (high speed RTA, fall from >3 m, high speed projectile).

26 A 10-year-old boy fell off a climbing frame onto the ground and injured his left elbow. He was assessed in the Emergency Department, and AP and lateral radiographs of his elbow were taken. What finding would be indicative of a fracture?

- a The anterior humeral line passing through the middle third of the capitellum on a lateral view
- b Non-visualisation of the lateral epicondyle
- c Visible anterior fat pad
- d Visible posterior fat pad
- e The radiocapitellar line intersecting the centre of the capitellum

26 Answer D: Visible posterior fat pad

Elevation of the anterior fat pad is abnormal, but it is often visible without

elevation as it sits in the shallow coronoid fossa of the humerus. Visualisation of the posterior fat pad is almost always abnormal, as it normally lies hidden within the deeper olecranon fossa.

27 An elderly woman tripped on the edge of the curb and fell to the ground. She prevented herself from hitting her head by putting her right hand out in front of her. Her past history was unremarkable other than osteoporosis diagnosed on a DEXA scan two years previously. Immediately after the injury she noticed pain and restricted movement in her right arm. What injury is most likely to be visible on radiographs of the humerus and shoulder?

- a Supracondylar fracture of humerus
- b Posterior dislocation of shoulder joint
- c Fracture of anatomical neck of humerus
- d Fracture of deltoid tuberosity of humerus
- e Fracture of surgical neck of humerus

27 Answer E: Fracture of surgical neck of humerus

The most likely injury in this context of falling on an outstretched arm, particularly in a patient with an osteoporotic humerus, is a fracture of the surgical neck, which is the point of weakness and is most easily fractured by an axial force. A fracture of the deltoid tuberosity is rare and would usually only occur with an avulsion by the deltoid tendon. The anatomical neck is not commonly fractured. Posterior dislocations are not common, occurring classically in the context of an epileptic fit or electrocution.



- 31 A six-year-old boy fell from a swing onto his outstretched hand. He was reluctant to use his right arm and complained of pain. A radiograph of the right radius and ulna was performed. What is the most likely abnormality?
- a Comminuted fracture of distal radius
  - b Pronator quadratus sign
  - c Monteggia fracture-dislocation
  - d Torus fracture of distal third of the radius
  - e Salter-Harris type III fracture of distal radial epiphysis

31. Answer D: Torus fracture of distal third of the radius

Common fractures in immature skeletons are torus (buckle) and greenstick fractures which occur due to the softer nature of immature bone, which is more likely to buckle on itself than fracture completely with moderate force. With greater force, a greenstick fracture can occur in which one cortex is fractured while the other bends. In both cases an excellent recovery is possible with closed reduction for six weeks. Monteggia fracture-dislocation is a fracture of the proximal ulna in conjunction with a dislocation of the distal radio-ulnar joint. It is rare, seen with significant trauma and not typical in a child. Salter-Harris type III fractures are also rare. The more common type of Salter-Harris fracture is a type II fracture. Comminuted distal fractures are not usually seen in children and would require a significant force to occur.

- 32 A 62-year-old man was involved in a road traffic accident. There was obvious bruising to the left side of his abdomen and urinalysis revealed microscopic haematuria. There was a delay in obtaining a CT due to a problem with the scanner and a FAST ultrasound examination was performed. What are FAST ultrasound studies able to detect?
- a In the absence of a full bladder FAST can assess for pelvic free fluid
  - b 10mL of ascitic fluid can be reliably detected
  - c There is a sensitivity of 40% for the detection of solid-organ injuries
  - d FAST scanning is solely for the evaluation of abdominal and pelvic pathology
  - e There is a specificity of 70% for mesenteric injuries

- 32 Answer C: There is a sensitivity of 40% for the detection of solid-organ injuries

The focused abdominal sonography for trauma (FAST) evaluation is usually performed on patients with blunt abdominal trauma to look for free fluid in the abdomen and pelvis. This usually includes sonography of the right upper quadrant, including the hepatorenal fossa; the left upper quadrant, including the perisplenic region; the right and left paracolic gutters; and the pelvis. Free fluid will gravitate to the most dependent portion of the pelvis and therefore may be missed if the patient has an empty bladder. In some instances an examination of the epigastrium is also performed. Other components of the examination include an intercostal or subdiaphragmatic view of the heart. Examination of the chest is performed if there has been chest as well as abdominal trauma. A few studies cite some benefit from serial measurements of ascitic fluid.

- 33 A 44-year-old back-seat passenger who was restrained with a lap seatbelt was involved in a high-speed road traffic accident. He complained of back pain and after full assessment was found to have a vertebral fracture. A CT scan of his abdomen revealed no intra-abdominal injuries. What is the most likely level of the fracture?
- a C7
  - b T2
  - c T6
  - d L1
  - e L4

- 33 Answer D: L1

A 'Chance' fracture describes a horizontal fracture through the spinous process, laminae, pedicles and vertebral body from a hyperflexion-distraction type of injury. It classically occurs as a result of deceleration affecting rear-seat passengers restrained in lap seatbelts and the thoraco-lumbar junction is the most common site of injury. A CT scan is the best modality for evaluating these fractures and other associated injuries (50% incidence of abdominal injuries with Chance fracture). Immobilisation is generally adequate treatment for these fractures; however, kyphosis of greater than 20 degrees is an indication for surgical fixation and spinal cord decompression as there may be instability.

- 70 A 15-year-old athlete presented with pain in the left side of their pelvis and was noted to have a flake of bone adjacent to the anterior inferior iliac spine on their radiograph, which corresponded to the area of tenderness. What muscle are they likely to have avulsed?
- a Adductor magnus
  - b Gracilis
  - c Psoas
  - d Rectus femoris
  - e Sartorius

70 Answer D: Rectus femoris

7. A 34-year-old female presents to the A&E department after falling on an outstretched hand. Examination reveals tenderness at the anatomic snuff box. A scaphoid radiograph series confirms scaphoid fracture. Which of the following features is most associated with a poor prognosis?
- A. Fracture of the distal third.
  - B. Fracture of the middle third.
  - ✓ C. Fracture of the proximal third.
  - D. Horizontal oblique fracture orientation.
  - E. Displacement of the scaphoid fat stripe.

7. C. Fracture of the proximal third.

Scaphoid fracture is the most common of all carpal bone fractures and also potentially serious due to the high rate of avascular necrosis. This fracture can be difficult to detect on initial radiographs. Wrist casting and repeat radiography after 1 week are typically advised if there is ongoing suspicion. Fractures of the proximal third account for 20% of injuries, but are associated with failure to unite in 90%. Middle third fractures make up the majority (70%), with up to 30% failing to reunite. Distal third fractures usually reunite. A vertical oblique fracture is more unstable than a horizontal oblique fracture. Fracture displacement of greater than 1mm is also a poor prognostic feature.

**10. A 24-year-old male presents to the A&E department with pain and swelling of his right thumb after landing against his ski pole while practising at the local dry ski-slope. An avulsion fracture at the base of the proximal phalanx is noted on a radiograph of the thumb. What underlying soft tissue structure has been injured to result in this fracture?**

- A. Ulnar collateral ligament.
- B. Radial collateral ligament.
- C. Joint capsule.
- D. Flexor pollicis longus tendon.
- E. Extensor pollicis longus tendon.

**10.A. Ulnar collateral ligament.**

The history and radiographic findings are typical of gamekeeper's thumb, which is an injury to the ulnar collateral ligament at its insertion site into the proximal phalanx of the thumb. This injury usually requires internal fixation to secure the ligament. Radial collateral ligament injuries of the thumb lead to painful deformity and articular degeneration. Rupture of flexor pollicis longus results in loss of active flexion of the thumb. The thumb remains in flexion with rupture of extensor pollicis longus. Thumb tendon injuries are typically seen in RA due to their susceptibility to synovitis.

**15. A 39-year-old male presents with tenderness and decreased range of movement of the right elbow after falling on an outstretched arm while playing indoor football. A radial head fracture is noted on his radiographs, but the A&E doctor asks for your opinion, suspecting an additional injury. What is the most common associated fracture with this injury?**

- A. Olecranon fracture.
- B. Coronoid process fracture.
- C. Scaphoid fracture.
- D. Proximal ulna fracture.
- E. Capitellum fracture.

**15.B. Coronoid process fracture.**

Radial head fractures are common, accounting for approximately one-third of all elbow fractures and up to 5% of all fractures in adults. A recent retrospective study found that associated fracture of the upper extremity was seen in 10.2% of patients, with fractures of the coronoid process the most common (4.1%). Radial head fracture, coronoid fracture, and medial collateral ligament tear form the 'terrible triad' of the elbow, which requires operative fixation.



**19. A patient attends A&E following an RTA in which she was the driver of car involved in a head-on collision. She complains of pain in both knees. Plain radiographs of the knees are unremarkable. Which of the following findings on MRI is most likely?**

- A. Bruising in the posterior aspect of the lateral tibial plateau and middle portion of the lateral femoral condyle.
- B. Bruising at the anterior aspect of the tibia.
- C. Kissing contusions in the anterior aspect of the distal femur and proximal tibia.
- D. Bruising in the lateral femoral condyle with a second smaller area in the medial femoral condyle.
- E. Bruising in the inferior medial patella and the anterior aspect of the lateral femoral condyle.

**19. B.** Bruising at the anterior aspect of the tibia.

Such bruising occurs in a dashboard injury when a posteriorly directed force is applied to the anterior aspect of the proximal tibia with the knee in flexion, such as occurs in an RTA. Bruising is also occasionally found in the posterior patella in this situation. Associated soft-tissue injuries are disruption of the posterior capsule and posterior cruciate ligament (PCL).

The pattern of injury in option A is caused by the pivot shift injury (valgus load in flexion combined with external rotation of the tibia or internal rotation of the femur). This will result in anterior cruciate ligament (ACL) disruption and the resultant anterior subluxation of the tibia causes impaction of the lateral femoral condyle against the posterolateral margin of the lateral tibial plateau. Soft-tissue injuries that may occur are tears of the posterior capsule, the posterior horn of the lateral or medial meniscus, and the medial collateral ligament (MCL). The kissing contusions in option C are as a result of hyperextension injury; resulting injuries may be to the ACL, PCL, or menisci. Option D describes the pattern found in clip injury, which involves a pure valgus stress while the knee is in mild flexion. The second area of bruising in the medial femoral condyle in this situation is due to avulsive stress to the MCL. The findings in option E are in keeping with transient lateral patellar dislocation, as discussed elsewhere in this chapter.

**20. An 18-year-old motorcyclist is involved in an RTA in which he was dragged by the colliding car. He is noted to have pain in his right shoulder and neck with associated paraesthesia. An MRI is requested, suspecting brachial plexus injury. What finding is most suggestive of nerve root avulsion?**

- A. Pseudomeningocele.
- B. Intradural nerve root enhancement.
- C. Spinal cord T2WI hyperintensity.
- D. T2WI hyperintensity within the paraspinal muscles.
- E. Thickening of the brachial plexus.

**20.A. Pseudomeningocele.**

Imaging in brachial plexus injury via CT myelography and/or MRI helps to determine whether the injury is pre- or postganglionic, which has therapeutic implications. Signal intensity changes in the spinal cord are seen in only 20% of preganglionic injuries and lack specificity. Intradural nerve root enhancement suggests functional impairment of the nerve roots, despite morphological continuity. This is not a common finding. T2WI signal intensity changes within the paraspinal muscles are observed in nerve root avulsion, but this is less accurate than enhancement on T1WI post contrast. Abnormal enhancement within the multifidus muscle is the most accurate of all paraspinal muscle findings since it is innervated by a single nerve root. Thickening of the brachial plexus, secondary to oedema and fibrosis, is seen in postganglionic injury. Traumatic pseudomeningocele, although not pathognomonic, is the most valuable sign of a preganglionic lesion.

**25. A 17-year-old female is admitted with multiple penetrating injuries to her arms after shielding her face from a nearby bomb blast while walking in the city centre. For which type of penetrating foreign body is ultrasound most superior for detection?**

- A. Gravel.
- / B. Wood.
- C. Plastic.
- D. Windshield glass.
- E. Bottle glass.

**25. B. Wood.**

Radiography is highly sensitive for foreign bodies considered radio-opaque. All glass material is radio-opaque to some degree on radiographs and does not need to contain lead. The role for ultrasound is limited to those foreign bodies that are radiolucent, such as wood and plastic. Wood appears hyperechoic with marked posterior acoustic shadowing. Ultrasound can detect wooden foreign bodies as small as 2.5 mm in length with 87% sensitivity and 97% specificity. Plastic is also radiolucent, but less echogenic than other foreign bodies on ultrasound.



**35. A 26-year-old man presents to the A&E department with wrist pain and swelling after falling from a ladder on an outstretched hand. The lateral radiograph demonstrates posterior dislocation of the capitate relative to the lunate. What is the most commonly associated fracture with this injury?**

- A. Capitate.
- B. Lunate.
- C. Triquetral.
- D. Scaphoid.
- E. Radius.

**35. D. Scaphoid.**

The findings describe perilunate dislocation, which is the most common carpal dislocation. It can occur without fracture (lesser arc injury) or with fracture (greater arc injury). Greater arc injuries are twice as frequent as lesser arc injuries. When describing these injuries the fracture is named first with the prefix 'trans' followed by the dislocation. Trans-scaphoid perilunate dislocation is the most common type of perilunate injury. Fractures of the trapezium, capitate, hamate, and triquetrum are also part of the greater arc injuries. Other radiographic signs of this injury include disruption of the carpal (Gilula) arcs and a triangular lunate on the AP view. An early sign is widening of the scaphoid-lunate space (Terry-Thomas sign), which suggests scapholunate dissociation. Lunate dislocation is the final stage of perilunate injuries, and is associated with the highest degree of instability.


**65. A 24-year-old man undergoes acute trauma to his right knee playing football. He is unable to weight bear. An x-ray of the right knee is performed and this demonstrates a large joint effusion and a small, avulsed elliptical fragment of bone at the medial aspect of the proximal tibia at the joint margin. Which knee structure is likely to be deranged in association with this injury at a subsequent MRI?**

- A. Anterior cruciate ligament.
- B. Posterior cruciate ligament.
- C. Lateral collateral ligament.
- D. Patellar tendon.
- E. Lateral meniscus.

**65. B. Posterior cruciate ligament.**

The avulsion injury described is a reverse Segond fracture. This injury is known to be associated with both mid-substance tears of the posterior cruciate ligament and avulsions of the PCL from the posterior tibial plateau. They can also be associated with medial meniscus injuries. They are not to be confused with a Segond fracture, which is a small elliptical fragment of bone avulsed from the lateral tibial plateau at the lateral joint margin, best seen on the AP view of the knee. They have a strong association with tears of the anterior cruciate ligament and also meniscal tears.

**69. A 30-year-old male presents with a history of painful heels after a fall from a height. Plain radiograph demonstrates calcaneal fractures. Which of the following statements regarding calcaneal fractures is true?**

- A. Extraarticular fractures represent 75% of all calcaneal fractures.
-  B. Calcaneal fracture classification is based on fracture line location at the posterior facet.
- C. Bilateral fractures are present in 30% of cases.
- D. The flexor hallucis longus tendon passes inferior to the sustentaculum tali on the lateral aspect of the calcaneus.
- E. Normal Boehler's angle is less than 20°.

**69. B. Calcaneal fracture classification is based on fracture location at the posterior facet.**

Calcaneal fractures represent 60% of fractures involving the tarsal bones. Axial loading resulting from a fall from a height is the most common cause followed by motor vehicle accidents. Treatment is based on accurate evaluation and classification of calcaneal fractures using multidetector CT reformats.

Calcaneal fractures are classified into intra-articular and extra-articular based on the involvement of the posterior facet of the subtalar joint. Intra-articular fractures, accounting for 75% of all calcaneal fractures, are further classified into four types depending on the number of fracture lines and fragments. Extra-articular fractures are classified into three types depending on whether the fracture involves the anterior, middle, or posterior aspect of calcaneus.

Bilateral fractures are seen in less than 10% of cases. Approximately 10% of calcaneal fractures are associated with compression injuries of the spine, commonly at the thoracolumbar junction.

Boehler's angle is formed by the intersection of (a) a line from the highest point of the posterior calcaneal tuberosity to the highest point of the posterior facet and (b) a line from the latter point to the highest of the anterior process. Normal Boehler's angle is 20–40°. An angle less than 20° indicates collapse of the posterior facet.

The sustentaculum tali is an eminence on the medial aspect of the calcaneus bearing the middle facet of subtalar joint.

- 2 A 35 year old man suffers a knee injury during a football match and presents with pain, swelling, knee locking and an inability to fully extend his knee. He undergoes an MRI examination.

**What is the most common site of injury?**

- (a) Anterior cruciate ligament
- (b) Posterior cruciate ligament
- (c) Anterior horn medial meniscus
- ✓ (d) Posterior horn medial meniscus
- (e) Anterior horn lateral meniscus

2 (d)

The symptoms described are more consistent with those of a meniscal injury, rather than a ligamentous tear. Such tears are commonest in the posterior horn of the medial meniscus.

- 8 A 12 year old boy falls and sustains a fracture to the proximal phalanx of his right index finger which extends from the articular surface to the epiphyseal plate but not extending to the metaphysis.

**What is the Salter-Harris classification of this injury?**

- (a) I epiphyseal strip
- (b) II physis & metaphysis
- ✓ (c) III
- (d) IV physis & metaphysis & epiphysis
- (e) V crush injury with vascular supply injury to physis

The prognosis gets worse as the grade increases

8 (c)

Type I (6–8%) is an epiphyseal slip. Type II (73–75%) extends through the physis separating a metaphyseal fragment. Type IV (10–12%) involves the metaphysis, physis and epiphysis. Type III (8–10%) is described. Type V (< 1%) is a crush injury with damage to the vascular supply to the epiphysis. Common sites include the distal radius (28%), hand phalanges (26%), and distal tibia (10%). The prognosis gets worse as the grade increases, with type V injuries particularly associated with subsequent growth disturbance. Lower extremity injuries are also associated with a worse prognosis than upper limb injuries.

- 9 A young man sustains blunt trauma to the chest. There is suspicion of a pneumothorax. A supine chest radiograph is available.

On this radiograph, which of the following would be the least supportive of this diagnosis?

- (a) Presence of the 'deep sulcus sign'
- (b) A sharply outlined dome of the diaphragm
- (c) A hyperlucent right upper abdominal quadrant
- (d) A sharply defined anterior junctional line
- ✓ (e) A poorly defined anterior cardiophrenic sulcus *in supine, air accumulates in the sulcus → appear well defined*

9 (e)

In the supine position, air may collect in the anterior cardiophrenic sulcus, which will therefore appear well defined against the inferior border of the heart.

**10 In the evaluation of a splenic injury following trauma, which of the following features favours pseudoaneurysm over active extravasation?**

- ✓(a) Less apparent on delayed imaging
- (b) Layering
- (c) Ill-defined
- (d) Increased size on delayed imaging
- (e) Jet of contrast medium

**10 (a)**

Pseudoaneurysms are typically well-defined, rounded and may be seen to have a neck adjoining an adjacent vessel. They are more difficult to detect on delayed images and there is no change in the haematoma. Management may be by embolisation or surgery depending on the clinical condition of the patient.

**11 A 32 year old man presents with a painful elbow, having fallen off his bicycle. AP and lateral radiographs of the elbow are taken; an A&E doctor is unsure if an abnormality is present and phones to ask your advice.**

**Which of the following indicates an underlying abnormality?**

- (a) A visible anterior fat pad
  - (b) On the lateral view, a line drawn through the long axis of the proximal radius passes through the capitellum
  - (c) The posterior fat pad is not visible
  - (d) 'Hourglass' or 'figure 8' sign of the distal humerus on lateral film
  - ✓(e) The anterior humeral line passes through the anterior third of the capitellum.
- More than one third of anterior capitellum should lie out for each humeral line, if not → a supracondylar fx should be suspected*



**11 (e)**

More than one third of the capitellum should lie anterior to the anterior humeral line – if not, a supracondylar fracture should be suspected. A visible posterior fat pad is always abnormal. Displacement of the anterior fat pad raises the possibility of a fracture. In a true lateral film the distal humerus appears to form an 'hourglass', loss of this or apparent asymmetry are indicators of a supracondylar fracture.

**17 You are asked to review a series of plain films of the cervical spine of an adult patient.**

**Which of the following is abnormal?**

- (a) On the lateral view, the distance between the anterior arch of C1 and the anterior aspect of the odontoid peg is 2 mm
- (b) On the lateral view, the soft tissues anterior to C2 are 9 mm thick
- (c) Harris' white ring is incomplete in its inferior aspect
- (d) On the lateral view, the C4-5 interspinous distance is 30% greater than the C5-6 interspinous distance
- (e) On the lateral view, the soft tissues anterior to C6 are 20 mm thick

**17 (b)**

The distance between the anterior arch of C1 and the anterior aspect of the odontoid peg should be no more than 3 mm in an adult. On the lateral view, the maximum width of the prevertebral soft tissues is: 7 mm at C1-4, 22 mm at C5-7. Harris' ring is often incomplete in its inferior aspect. On the long AP view, no single interspinous distance should be more than 50% wider than the one immediately above or below it.



- 20 A young man is involved in an RTA and arrives in hospital with a markedly reduced GCS. Anterior tilt of the odontoid peg is noted and an oblique fracture line is seen through the upper portion of the dens.

Which type of odontoid fracture is this?

- (a) Type I
- (b) Type II
- (c) Type III
- (d) Type IV
- (e) Type V



3 - non displaced

20 (a)

Type I: a fracture through the upper portion of the dens. Type II: a transverse fracture through the junction of the dens and the body of the axis. Type III: a fracture through the body of the axis. There is no type IV nor V.

- 21 Following penetrating abdominal trauma, which organ is most frequently injured?

- (a) Liver
- (b) Pancreas
- (c) Spleen
- (d) Kidney
- (e) Small bowel

The spleen is the most frequently injured after BLUNT trauma

21 (a)

The spleen accounts for 40% of organ injuries following blunt abdominal trauma, with the liver accounting for 20%. If penetrating trauma is taken in to account as well, the liver is the most commonly injured organ.

- 24 A 32 year old man falls on his outstretched right wrist whilst playing football. Wrist X-ray reveals a displaced, oblique intra-articular fracture of the dorsal lip of the distal radius.

What is the fracture type described?

- (a) Barton's
- (b) Chauffeur's
- (c) Colles'
- (d) Smith's
- (e) Salter Harris Type II

24 (a)

A Barton's fracture refers to an intra-articular fracture through the distal radius. The conventional Barton fracture involves the dorsal rim of the radius, the reverse Barton involves the volar rim. Salter-Harris fractures involve the growth plate before closure; the other types described are not intra-articular. Colles' and Smith's are fractures of the distal radius with dorsal and volar displacement of the distal fragments, respectively. A chauffeur fracture is a triangular fracture of the radial styloid process.

- 
- 26 Which of the following statements regarding blunt thoracic trauma is not true?

*the aortic & mitral are more affected*

- (a) Pericardial injuries are usually left sided
- (b) The tricuspid valve is the most commonly injured valve
- (c) Cardiac herniation through the pericardium may result in cardiac dysfunction
- (d) The right ventricle is injured more frequently than the left
- (e) Blunt cardiac injuries are most commonly the result of road traffic accidents

26 (b)

The aortic and mitral valves are more commonly affected.

- 28 A 14 year old boy is referred for a CT following blunt abdominal trauma. This demonstrates a transection of the distal pancreas with free fluid in the peri-pancreatic space.

According to the American Association for the Surgery of Trauma (AAST), what grade is this injury?

- (a) Grade I → minor contusion/superficial laceration
- (b) Grade II → major contusion/laceration without duct injury
- (c) Grade III → distal transection involving the duct
- (d) Grade IV → injury involving ampulla or bile duct
- (e) Grade V → massive disruption of pancreatic head

28 (c)

Grade I injury is a minor contusion/superficial laceration. Grade II injury is a major contusion/laceration without duct injury. Grade III injury is a distal transection/injury involving the duct. Grade IV injury is a proximal transection or injury involving the ampulla or bile duct. Grade V injury is massive disruption of the pancreatic head.

- 29 A man suffers a supination-abduction ankle injury. Plain films reveal an oblique fibular fracture through the tibiofibular syndesmosis.

Which Weber category does this represent?

- (a) A
- ✓ (b) B
- (c) C
- (d) D
- (e) E



29 (b)

The Weber classification is based on the location of the distal fibular fracture relative to the tibiotalar joint. Type A is a transverse fracture distal to the ankle joint; type B is an oblique fracture at the level of the joint; type C is a fibular fracture proximal to the level of the joint. There is no type D or E.

- 33 A patient has injured his knee and is unable to weight bear.  
AP and lateral radiographs are taken.

Which of the following is an abnormal finding?


- (a) On the lateral view, the distance from the lower pole of the patella to the tibial tubercle is 1.5 times the length of the patella *patellar tendon on lateral view is 2x patella length 2/3*
- (b) There is irregularity of the tibial tubercle
- (c) On the AP view, a perpendicular line drawn from the lateral margin of the femoral condyle has 3 mm of the lateral margin of the tibial condyle outside of it *upto 5mm is normal*
- (d) There is a corticated, calcified body in the lateral head of the gastrocnemius muscle  $\Rightarrow$  fabella
- (e) There is a multipartite patella

33 (a)

On the lateral view, the distance from the lower pole of the patella to the tibial tubercle should equal the length of the patella plus or minus 20%. If this rule is broken, a ruptured patellar ligament must be suspected. On the AP view a perpendicular line drawn from the lateral margin of the femoral condyle should have  $\leq 5$  mm of the lateral margin of the tibial condyle outside of it. The fabella is a common sesamoid bone within the lateral head of gastrocnemius.

- 34 A patient presents with foot and ankle tenderness after a sports injury. Plain radiographs of the ankle and foot are taken.

Which of the following is an abnormal finding?

- (a) Bohler's angle is 31 degrees *30-40*
- (b) On an AP view of the midfoot, the medial margin of the second metatarsal aligns with the medial margin of the intermediate cuneiform
- (c) On an AP view of the midfoot, the medial margin of the third metatarsal aligns with the medial margin of the lateral cuneiform
-  (d) The width of the space between the distal tibia and fibula at a point 1 cm from the articular surface is 8 mm *≤ 6 mm*
- (e) On the AP view of the midfoot, there is a lucent line through the base of the 5th metatarsal which runs parallel to the metatarsal shaft

34 (d)

The width of the space between the distal tibia and fibula at a point 1 cm from the articular surface should be  $\leq 6$  mm. Bohler's angle is normally 30–40 degrees. In contradistinction to a fracture, the long axis of an unfused apophysis of the base of the 5th metatarsal runs parallel to the metatarsal shaft. On an AP view of the midfoot, the medial margin of the second metatarsal should align with the medial margin of the intermediate cuneiform. On an AP view of the midfoot, the medial margin of the third metatarsal aligns with the medial margin of the lateral cuneiform.

- 36 A patient has injured his right shoulder. An AP view demonstrates an acromio-clavicular distance of 12 mm and a coraco-clavicular distance of 10 mm. The clavicle is not otherwise grossly displaced.

What is the grade of the acromio-clavicular joint injury?

- (a) Grade I → normal radiograph  
 (b) Grade II → A-C > 8-10 mm CC ≤ 13 mm  
 (c) Grade III → A-C > 8-10 mm CC > 13 mm  
 (d) Grade IV → Total dislocation, clavicle is dislocated into trapezius  
 (e) Grade V → Total dislocation, clavicle is dislocated into neck.  
 Grade VI → Total dislocation, clavicle is dislocated inferiorly

Grade	Features
I	Normal radiograph
II	AC distance > 8–10 mm; CC distance ≤ 13 mm
III	AC distance > 8–10 mm; CC distance > 13 mm
IV	Total dislocation, clavicle dislocated into trapezius
V	Total dislocation, clavicle dislocated into neck
VI	Total dislocation, clavicle dislocated inferiorly

- 38 A patient presents with tenderness in the anatomical snuffbox and a scaphoid series of plain radiographs are taken. There is a fracture across the proximal pole of the scaphoid.

Which of the following is incorrect?

- (a) Compared to other scaphoid fractures, those across the proximal pole have the highest risk of avascular necrosis  
 (b) Most scaphoid fractures occur across the waist  
 (c) Most scaphoid fractures are not displaced  
 (d) Scaphoid waist fractures may take up to 2 years to heal  
 (e) A vertical oblique fracture is considered more stable compared to a transverse fracture

• Proximal pole avascular  
 • 80% of # across waist  
 • 80% of # across waist



**38 (e)**

Fractures across the proximal pole and waist both carry a high risk of subsequent AVN. 80% of fractures occur across the waist, compared to 10% for each of the poles. Transverse/horizontal oblique fractures are relatively stable compared to vertical oblique fractures.

**40 A patient presents with suspected transient patellar dislocation. MR imaging is performed.**

**Which of the following MR imaging features would be least expected in this condition?**

- (a) Disruption of the medial retinaculum
- (b) Lateral patellar tilt
- (c) Elevation of the vastus medialis obliquus muscle
- ✗ (d) Bone contusion of the medial aspect of the medial femoral condyle
- (e) Bone contusion of the inferomedial aspect of the patella

**40 (d)**

In transient patella dislocation, the patella dislocates laterally and then relocates. This causes impaction between the inferomedial aspect of the patella and the anterolateral aspect of the lateral femoral condyle, which results in bone contusions. In addition to the above signs, a haemarthrosis is also usually present.

- 43 A CT is performed following major trauma. A Hangman's fracture is suspected.**

**Which of the following features would be unusual with this diagnosis?**

- (a) Avulsion of the anteroinferior corner of C2
- (b) Posterior subluxation of C2 on C3
- (c) Bilateral pars fracture of C2
- (d) Prevertebral soft tissue swelling
- (e) Disruption of the C1-C2 spinolaminar line

**43 (b)**

The Hangman's fracture is a traumatic bilateral neural arch fracture, most commonly of the pars, resulting from hyperextension. When subluxation occurs, it is more commonly an anterior, rather than posterior subluxation of C2 on C3.

- 2 A gentleman presents to A&E after trauma. Plain radiographs of the cervical spine are taken. There is an abrupt transition in the alignment of the cervical spine at C5-6, with anterolisthesis of C5 on C6 by 3/4 of a vertebral body's width.**

**Which of the following is incorrect?**

- (a) There is a high incidence of cord injury
- (b) This is a stable dislocation
- (c) The posterior ligament complex is disrupted
- (d) The anterior longitudinal ligament is disrupted
- (e) The facets may be in a 'batwing' or 'bow-tie' configuration

**2 (b)**

Given the extent of anterolisthesis (>50% of a vertebral body), this is most likely to represent bilateral, rather than unilateral facet dislocation, and therefore an unstable injury.

- 4 A 40 year old man with chronic renal failure is involved in an RTA and presents with abdominal pain. Unenhanced CT shows a small volume of free intra-abdominal fluid of mixed attenuation.**

**Which of the following is the likeliest source of haemorrhage?**

- (a) Right lobe of the liver
- (b) Left lobe of the liver
- (c) Spleen
- (d) Body of pancreas
- (e) Small bowel mesentery

**4 (c)**

The spleen is the most commonly injured organ in blunt abdominal trauma. Second most common is the liver (20%), then the GI tract (5%), pancreas (3%), and gallbladder (2%). The right lobe of the liver is more commonly injured than the left.

- 7 A 20 year old man presents after a fall with anatomical snuff box tenderness.**

**Which of the following statements is incorrect?**

- (a) 40% of scaphoid fractures are visible on initial radiographs
- (b) Interval radiographs at 7–10 days detect the majority of initial occult fractures
- (c) The MRI sequences of choice are coronal T1 and STIR
- (d) 80% of fractures occur through the waist of the scaphoid
- (e) Distal radius fractures can present in this manner

**7 (a)**

85% of scaphoid fractures are detectable initially using scaphoid views. Repeat views are commonly obtained but detection of occult fractures are unreliable. Nuclear imaging is sensitive but non-specific. MRI is the best test for detection of occult fracture. However, lack of availability means that other tests are still used.

- 12 A CT is performed following major trauma. A cervical burst fracture is suspected.**

**Regarding this condition, which of the following statements is incorrect?**

- (a) Interpedicular widening is common
- (b) Injury to the spinal cord is common
- (c) There are commonly fragments within the spinal canal
- (d) There is loss of posterior vertebral body height
- (e) This is considered an unstable fracture

**12 (e)**

This is considered to be a stable fracture. All patients require CT to identify fracture fragments (most commonly from the posterior, superior margin) within the spinal canal.

- 17 A young man avulses his anterior inferior iliac spine whilst kicking a football.**

**The origin of which muscle will be affected?**

- (a) Adductor magnus
- (b) Iliopsoas
- (c) Rectus femoris
- (d) Sartorius
- (e) Tensor fasciae latae

**17 (c)**

The anterior inferior iliac spine is the origin of rectus femoris.

- 18 A man falls from a balcony and is brought into A&E. There is clinical shortening of the left leg and plain radiographs demonstrate fractures through the left sacroiliac joint and the left pubic rami.**

**What is the most appropriate description of this fracture?**

- (a) Bucket-handle
- (b) Duverney
- (c) Open-book
- (d) Malgaigne
- (e) Wide-swept pelvis

**18 (d)**

A Malgaigne fracture typically involves two fractures, both on the same side of the pelvic ring: one anterior to the acetabulum (e.g. both pubic rami) and one posterior to the acetabulum (e.g. through the ilium, or the SI joint).

- 20 A young man sustains blunt trauma to the chest. There is a suspicion of thoracic aortic injury.**

**With this in mind, which of the following measurements is considered abnormal?**

- (a) The mediastinum is 6 cm wide at the level of the origin of the left subclavian artery
- (b) The left paraspinal stripe is 3 mm wide
- (c) The right paratracheal stripe is 2 mm wide
- (d) There is depression of the left mainstem bronchus of 60° below the horizontal
- (e) The right hemidiaphragm is higher than the left

**20 (d)**

Signs of aortic injury include: depression of the left mainstem bronchus  $> 40^\circ$  below the horizontal; mediastinal widening  $> 8$  cm at the level of the origin of the left subclavian artery; an indistinct aortic contour at the arch; obscuration of the aortopulmonary window; a widened left paraspinal stripe  $> 5$  mm; a widened right paratracheal stripe  $> 4-5$  mm; an apical pleural cap.

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**22** A 35 year old man involved in an RTA falls from a motorcycle and injures his forearm. Plain radiographs show a comminuted displaced radial head fracture with dislocation of the radioulnar joint.

**What is the eponymous term for this injury?**

- (a) Monteggia fracture
- (b) Reverse Monteggia fracture
- (c) Essex-Lopresti fracture
- (d) Galeazzi fracture
- (e) Maisonneuve fracture

**22 (c)**

A Galeazzi fracture is radial shaft fracture with subluxation/ dislocation of the distal radioulnar joint. A Monteggia fracture is a fracture of the ulnar shaft with dislocation of the radial head. The reverse version refers to the angulation/ displacement of the ulnar fracture and radial head dislocation. A Maisonneuve fracture refers to a fracture of the upper third of the fibula with a tear of the distal tibiofibular syndesmosis.



- 24 CT imaging is performed on a patient with known malignancy who is unwell. There appears to be fluid within the abdominal cavity. This has an attenuation of 40 HU. The images were acquired in the portal venous phase after the administration of *i.v.* contrast medium.

**What type of fluid/ tissue is this most likely to represent?**

- (a) Fat
- (b) Serum
- (c) Fresh unclotted blood
- (d) Clotted blood
- (e) Active arterial extravasation

**24 (c)**

CT Attenuation	Type of fluid
0–20	Serum/ascites
30–45	Fresh unclotted blood
60–100	Clotted blood
>180	Active arterial extravasation

- 25 A CT is performed after blunt abdominal trauma. Images were acquired in the portal venous phase after the administration of *i.v.* contrast medium. Clinically, the patient is thought to be hypovolaemic.

**Which of the following is not a CT imaging feature of hypovolaemia?**

- (a) Normal enhancement of the adrenal gland
- (b) Normal enhancement of the spleen
- (c) Flattening of the IVC
- (d) Dilatation and mural enhancement of the bowel
- (e) Normal enhancement of the pancreas

**25 (b)**

The spleen tends to be small and hypodense in hypovolaemia. As well as the features above, there may be a 'shock nephrogram', and the aorta and mesenteric arteries may be small.

**36 A 35 year old man involved in an RTA presents to A&E with lower neck pain. The mechanism of injury is thought be one of flexion. Cervical and thoracic spine films are obtained.**

**Which of the following flexion fractures would you describe as being unstable?**

- (a) Anterior subluxation
- (b) Clay-Shoveler's fracture
- (c) Flexion teardrop fracture
- (d) Unilateral facet joint dislocation
- (e) Wedge compression fracture

**36 (c)**

Neutral films infer stability based on fracture type; stability is a function of ligamentous injury and thus cannot be implied with 100% accuracy, if doubt remains MRI or flexion/ extension views should be obtained. The other type of unstable flexion injury is a bilateral facet joint dislocation. Unstable extension injuries include Hangman's fracture and hyperextension-dislocation fracture; stable extension injuries include posterior arch of C1 fracture, laminar fracture, Pillar fracture, and extension teardrop fracture. Jefferson's fracture is an unstable compression fracture, burst fracture a stable one. 'Complex' unstable fractures include odontoid fracture and atlanto-axial disassociation.

- 47 A patient presents following a head injury. CT confirms an intracranial bleed.**

**Which of the following more accurately describes a subdural, rather than epidural haematoma?**

- (a) It is biconvex in shape
- (b) It commonly associated with skull fractures
- (c) It may cross the midline
- (d) It separates the venous sinuses from the inner table of the skull
- (e) It is usually arterial in origin

**47 (c)**

A subdural haematoma can cross the dural reflections, including the falx, and therefore cross the midline.

- 60 A 30 year old man is hit by a car sustaining a 'bumper' type injury. Radiographs show a bicondylar tibial plateau fracture with an 'inverted Y' appearance.**

**In the Schatzker classification, which type of fracture is this?**

- (a) I
- (b) II
- (c) III
- (d) IV
- (e) V

**60 (e)**

Type I (6%) is a pure wedge shaped cleavage fracture. Type II (25%) is a mixed cleavage and median compression fracture. Type III (36%) is a pure compression (depression) fracture. Type IV (10%) is a medial comminuted plateau fracture. Type VI (20%) is a transverse/oblique fracture separating the metaphysis from the diaphysis. Type V fractures are the rarest.

- 69 A young man was involved in an RTA 48 hours ago and is currently an inpatient in the trauma centre. He becomes dyspnoeic. Fat embolism is suspected.**

**Which features would be very unusual in this condition?**

- (a) A normal chest radiograph at 48 hours
- (b) Bilateral diffuse alveolar infiltrates at 48 hours
- (c) Petechiae
- (d) Neurological symptoms
- (e) Cardiomegaly

**69 (e)**

The onset is 24-72 hours after trauma (the chest radiograph may be normal up to 72 hours). The radiographic appearance can be similar to pulmonary oedema, however, the heart size is normal.

- 74 A CT is performed for polytrauma. A Jefferson fracture is suspected.**

**Which of the following appearances is consistent with this diagnosis?**

- (a) Bilateral anterior arch fractures
- (b) Bilateral posterior arch fractures
- (c) Unilateral anterior and posterior arch fractures
- (d) Bilateral fractures of the superior articular facets
- (e) Bilateral transverse process fractures

**74 (c)**

A Jefferson fracture involves both the anterior and posterior arches, and may be either unilateral or (more usually) bilateral.



1) A 34-year-old woman presents with pain and swelling of the right knee over the previous 2 months. Plain films demonstrate a well-circumscribed, expansile, lytic lesion eccentrically located in the subarticular region of the right distal femur. The lesion has a narrow, non-sclerotic zone of transition. What is the most likely diagnosis?

- a. giant cell tumour
- b. enchondroma
- c. fibrous cortical defect *metaphyseal, asymptomatic, age < 30*
- d. fibrous dysplasia
- e. aneurysmal bone cyst

1) a. \*\*

The vast majority of giant cell tumours occur in patients with closed epiphyses, and although they may originate in the metaphysis, lesions typically involve the epiphysis and abut the subarticular surface. They are classically eccentrically located lesions with a narrow zone of transition, no sclerosis, and no internal matrix mineralization. Giant cell tumours tend to be locally aggressive, with a high recurrence rate after initial treatment. Enchondromas are the commonest benign cystic lesion of the phalanges, though they are also seen in the long bones. However, those in the long bones almost always contain calcified chondroid matrix. Aneurysmal bone cysts are often seen as an eccentric lytic expansile lesion, but patients are nearly all under the age of 30. Monostotic fibrous dysplasia is more commonly seen in the proximal femur than distally, and lesions tend to have a sclerotic margin. Fibrous cortical defects are asymptomatic lesions seen in children, which usually regress spontaneously, so they are only rarely seen after the age of 30. They typically appear as lytic lesions with a thin sclerotic border in the metaphysis of a long bone.



8) A middle-aged man with no significant medical history undergoes a radiograph of the pelvis for localized tenderness following a fall. Multiple longitudinally orientated, 2–10 mm rounded densities similar to cortical bone are seen throughout the cancellous bone, in a diffuse symmetrical pattern concentrated around the acetabulum. There is no fracture. What is the most likely diagnosis?

- a. osteopathia striata (Voorhoeve's disease) causes linear longitudinal
- b. osteopetrosis → generalised ↑ in bone density
- c. bone metastases
- d. melorheostosis flowing wax
- e. osteopoikilosis multiple bony islands (asymptomatic)

8) e. \*\*\*

Osteopoikilosis is a rare condition causing multiple enostoses (bone islands), which are asymptomatic and usually of no clinical significance. They represent deposits of normal cortical bone within the cancellous bone. Osteopathia striata (Voorhoeve's disease) is similar to osteopoikilosis in appearance and is usually asymptomatic, but it consists of linear longitudinal or sunburst striations rather than rounded densities. Osteopetrosis causes generalized increase in bone density, whereas melorheostosis is a cortical process giving a 'flowing wax' appearance, usually affecting only one side of the affected bone. While metastases are plausible, the patient would probably be symptomatic and have evidence or a history of a primary tumour.

13) A 'fallen fragment' seen within a lytic bone lesion is most commonly associated with which of the following?

- a. aneurysmal bone cyst
- b. unicameral (simple) bone cyst
- c. giant cell tumour
- d. eosinophilic granuloma
- . e. chondroblastoma

13) b. \*\*

The **fallen fragment** is **virtually pathognomonic** for a **simple bone cyst**. It represents a fragment from a pathological fracture through the lesion, which has fallen to lie in a dependent location in the cyst matrix.

19) The presence of punctate, ring-like or arcuate calcification in a lytic bone lesion on plain radiography is most commonly associated with which of the following matrix types?

- a. osteoblastic
- b. fibrous
- c. cartilaginous
- d. cellular
- e. mixed

19) c. \*\*

Chondroid tumour matrix may or may not calcify, but, if it does, the pattern is characteristically in arcs or circles and is sometimes described as 'popcorn'. **Osteoid matrix** when calcified is **usually dense and homogeneous** like a cloud. **Calcified fibrous matrix** has a **characteristic ground-glass appearance**, whereas a cellular tumour usually does not show matrix calcification. A mixed matrix will show mixed characteristics.

23) Plain radiographs of the hands in a young woman are performed for unilateral deformity. These show multiple lytic lesions in the medullary cavities of the tubular bones with cortical expansion and matrix mineralization, and associated Madelung deformity. The changes are unilateral. What is the most likely diagnosis?

- a. Maffucci's syndrome
- b. Ollier's disease
- c. Trevor's disease
- d. Lichtenstein-Jaffé disease
- e. Morquio's syndrome

Madelung = wrist deformity due to growth disturbance of radius.

23) b. \*\*\*

Ollier's disease or multiple enchondromatosis is characterized by the presence of benign intraosseous cartilaginous tumours. The estimated prevalence of the disease is 1 in 100 000. The distribution and number of lesions are variable, but are often unilateral and monomelic.

Complications include pain, skeletal deformities, limb length discrepancy (including Madelung's deformity) and the potential risk of malignant change to chondrosarcoma in 20–50% of cases. The condition in which enchondromas are associated with haemangiomas is known as Maffucci's syndrome. Neither is usually inherited. Trevor's disease is an epiphyseal dysplasia, whereas Lichtenstein–Jaffé disease is another

name for fibrous dysplasia. Morquio's syndrome is one of the lysosomal storage disorders known as the mucopolysaccharidoses.

24) Of the following types of periosteal reaction, select the one most likely to indicate a benign process?

- a. soap-bubble
- b. sunray
- c. hair-on-end
- d. laminated
- e. Codman's triangle

24) a. \*\*

Periosteal reactions are usually a radiographic manifestation of underlying bone disease. The term 'soap bubble' refers to expansion of the cortex without destruction by a lytic bone lesion. The intact cortex usually indicates a benign process, whereas cortical destruction is associated with malignant or aggressive lesions. Sunray and hair-on-end reactions are spiculated forms of periosteal reaction that occur following periosteal elevation by tumour, with tumour preventing the subperiosteal space from filling with new bone. Laminated or 'onion-skin' reaction occurs with both malignant and benign processes and indicates an intermittent or cyclical process. Codman's triangles are formed by elevation and then destruction of the periosteum. They are usually related to malignant tumours but can also be formed by aggressive benign processes.

35) A 19-year-old man presents to his general practitioner with a sudden onset of painful scoliosis. His pain improves with prescribed aspirin while awaiting MRI. MRI reveals a localized area of inflammatory change in the left pedicle of L1. Subsequent CT shows marked sclerosis in the same region with a 5 mm, cortically based central lucency. What is the most likely cause?

- a. plasma cell cytoma
- b. osteosarcoma
- c. osteoid osteoma
- d. Brodie's abscess
- e. lymphoma

35) c. \*\*

Osteoid osteoma accounts for 12% of benign neoplasms of bone. It is most commonly located in the cortex of long bones (50% in the femur and tibia) with 15% in the spine, typically the pedicle. It rarely exceeds 15 mm in size. Young men are most commonly affected, with pain as the predominant presenting feature due to the extensive inflammatory reaction and vascularity of the lesion. With spinal lesions this results in a painful positional scoliosis, though the majority of patients experience



improvement of the pain with salicylates. The lucent central area or nidus represents the underlying pathological process, with the surrounding sclerosis representing reactive inflammatory change in normal bone. Treatment traditionally was surgical curettage, but radiologically guided percutaneous radiofrequency ablation is now used.

42) On MRI performed for a tender osteochondroma of the femoral metaphysis in an adult, which feature is most useful in determining the presence of malignant change?

- a. thickness of the cartilage cap
- b. lesion size
- c. compression of local nerves
- d. fracture of the stalk
- e. bursa formation

42) a. \*\*

Osteochondromas are the commonest bone tumours and are considered developmental exostoses rather than true neoplasms. They represent 20–50% of benign and 10–15% of all bone tumours. They are made up of cortical and medullary bone and an overlying cartilage cap. The cortex and medulla of the osteochondroma are continuous with the underlying host bone. They are typically orientated away from an adjacent distal joint. Lesions are frequently solitary, but multiple lesions are seen in hereditary multiple exostoses, an autosomal dominant syndrome. Malignant transformation occurs in 1% of solitary lesions and in 3–5% of patients with hereditary multiple exostoses. After skeletal maturity, continued lesion growth, particularly of the cartilage cap, is suggestive of malignant transformation. Although benign lesions may reach 10 cm in size, the cartilage cap should not exceed 1.5 cm after skeletal maturation. Any bone that develops by enchondral ossification may develop an osteochondroma, the long bones of the lower extremity being most frequently affected.

91) A 70-year-old man undergoes CT of the skull for investigation of clinically apparent macrocephaly confirmed on skull radiography. You are asked by the referring clinician to review the images. Which finding is most likely to support a diagnosis of fibrous dysplasia over Paget's disease?

- a. widened diploë
- b. asymmetrical involvement of the skull
- c. sparing of the paranasal sinuses
- d. osteoporosis
- e. ground-glass medulla

91) e. \*\*

A ground-glass appearance is characteristic of fibrous dysplasia and is the most useful discriminating factor. Other features of fibrous dysplasia of the skull that can help distinguish it from Paget's disease are symmetry of distribution, presence of a soft-tissue mass, cyst-like changes, thickness of the cranial cortices, and involvement of the paranasal sinuses, maxilla, sphenoid, orbits and nasal cavity.

100) Plain radiographs of the femur performed for pain reveal a centrally located lucent lesion in the medulla with a partially calcified matrix. Which of the following features favours a diagnosis of chondrosarcoma over enchondroma?

- a. arc-and-ring matrix calcification
- b. ground-glass matrix
- c. multiple lesions
- d. deep endosteal scalloping
- e. lesion size over 5 cm



100) d. \*\*\*

Distinction of enchondroma and intramedullary chondrosarcoma in the appendicular skeleton proximal to the metacarpals/-tarsals is difficult radiologically. A series of 187 patients showed that chondrosarcoma was associated with endosteal scalloping, with scalloping involving more than two-thirds of the extent of the lesion being strongly suggestive of malignancy. Other powerful discriminating factors identified as favouring chondrosarcoma were cortical destruction, soft-tissue mass, periosteal

reaction, radionuclide uptake at scintigraphy and pain associated with the lesion. Chondrosarcoma also tended to be larger with a mean size of 10 cm compared with 6.7 cm for enchondroma. A ground-glass matrix with arcuate calcification is characteristic of both types of cartilaginous lesion. Multiple lesions may be seen in both malignancy and enchondromatosis (Ollier's disease).

1. A 17 year old girl presents with pain in the distal forearm which has worsened over the last six to eight weeks. Plain films show an eccentric lytic radiolucency in the distal radius with a soap-bubble appearance. The most likely pathology is:
  - a. Enchondroma
  - b. Aneurysmal bone cyst
  - c. Simple bone cyst
  - d. Fibrous dysplasia
  - e. Chondroblastoma

1. b. Aneurysmal bone cyst

Aneurysmal bone cyst is most common in females and 75% occur under 20 years of age. The classic presentation is of pain of relatively acute onset with a rapid increase in severity over 6–12 weeks. Common locations include the spine, with a slight preponderance for the posterior elements, and the metaphysis of long bones – femur, tibia, humerus and fibula. The lesion is usually expansile with thin internal trabeculations giving it the characteristic soap-bubble appearance.

4. A 20 year old man presents with an increasingly painful right thigh which is worse at night. Plain films of the area show a lucent area measuring approximately 8–9 mm in the distal femur surrounded by extensive sclerosis. The most likely diagnosis is:
- a. Osteoblastoma
  - b. Giant cell tumour
  - c. Brodie's abscess
  - d. Osteoid osteoma
  - e. Chondroblastoma

**4. d. Osteoid osteoma**

This most commonly presents in the second and third decades. The male:female ratio is 2.5:1. Classically it presents with increasing pain which is worse at night and often relieved with aspirin. Spinal lesions often lead to painful scoliosis. Almost any site in the body may be affected but the most common regions are the lower limb and spine.

28. An 18 year old student who fell down two stairs and landed on her left knee attends A&E complaining of generalised knee pain but is able to weight bear. No acute bony injury is demonstrated on plain film, however a pedunculated lesion arising from the femoral metaphysis and extending away from the knee joint is seen. The lesion shows continuity with both the marrow and the cortex. The most likely diagnosis is:
- a. Osteochondroma
  - b. Osteoblastoma
  - c. Osteoid osteoma
  - d. Chondroblastoma
  - e. Chondromyxoid fibroma

**28. a. Osteochondroma**

The description is classic for an osteochondroma or osteocartilagenous exostosis. These lesions are the most common benign growths of the skeleton, are usually found incidentally and are usually asymptomatic unless complications arise. Complications include fracture, vascular compromise, bursa formation and malignant transformation into chondrosarcoma.

38. A 25 year old woman attends A&E after falling onto her right hand. A plain film of her hand is taken in order to exclude fracture. No bony injury is seen. On examination, however, there is painless swelling of the right index finger which she says has been present for a few weeks. Incidental note is made of a small central lesion within the medullary cavity of the middle phalanx of the index finger. There is no cortical breakthrough or periosteal reaction but there is bulbous expansion of the bone with thinning of the cortex. The lesion contains dystrophic calcifications. This is most likely to represent:
- a. Giant cell tumour of the tendon sheath
  - b. Unicameral bone cyst
  - c. Brown tumour
  - d. Enchondroma
  - e. Epidermal inclusion cyst

**38. d. Enchondroma**

This lesion is most likely to be an enchondroma. This is a benign cartilaginous growth in the medullary cavity and is usually asymptomatic. It most commonly occurs in the small bones of the hands and wrist but may also occur in the proximal humerus and proximal femur. Epidermoid inclusion cysts are usually in the distal phalangeal tuft and there is often a history of trauma. A bone cyst would be unusual in the phalanges.

53. An 18 year old man undergoes a Tc MDP bone scan to investigate pain in the right hip. A 'hot' lesion is seen in the right proximal femur. No other lesions are seen. Which of the following lesions would appear as 'hot' on a Tc MDP bone scan?
- a. Osteopoikilosis
  - b. Fibrous cortical defect
  - c. Acute fracture within 12 hours of injury
  - d. Fibrous dysplasia
  - e. Haemangioma

**53. d. Fibrous dysplasia**

The most common site of monostotic fibrous dysplasia is the ribs, followed by proximal femur and craniofacial bones. Three-quarters of cases present before age 30. Other benign lesions causing a 'hot' on bone scan include Paget's disease, brown tumours, aneurysmal bone cysts, osteoid osteoma and chondroblastoma.

Acute fractures are not usually 'hot' until after the first 24–48 hours.

55. A 29 year old woman presents with a painful right knee which has been worsening over the previous few weeks. A plain film of the right knee shows an oval expansile lesion with a radiolucent centre in the metaphyseal region of the proximal tibia. There is a sclerotic margin and geographic bone destruction. There are internal septations and stippled calcification. There is no periosteal reaction. The most likely diagnosis is:
- a. Non-ossifying fibroma
  - b. Chondroblastoma
  - c. Giant cell tumour
  - d. Chondromyxoid fibroma
  - e. Chondrosarcoma

55. **d. Chondromyxoid fibroma**

This is most commonly seen in the second and third decades and the most common site is the long bones, most often the proximal tibia and distal femur. Non-ossifying fibroma is usually asymptomatic. The appearances of a chondroblastoma would be similar but this would most likely be epiphyseal in location and usually presents in a slightly younger age group.

- 8 A 23-year-old male had a chest radiograph as he was short of breath after falling from his bicycle. The mediastinum and lungs appeared normal but an area of fibrous dysplasia was noted. Which type of fibrous dysplasia is most common?
- a McCune-Albright syndrome
  - b Polyostotic
  - c Craniofacial
  - d Monostotic
  - e Familial

8 Answer D: Monostotic

Fibrous dysplasia is a skeletal developmental anomaly of bone forming mesenchyme, which manifests as a defect in osteoblastic differentiation and maturation. Almost any bone can be affected. Monostotic is found in 70–80%. Polyostotic is found in 20–30% and can be associated with endocrine dysfunction and café au lait spots in 10%. Craniofacial is rarer (10–25% of monostotic, 50% of polyostotic). The familial form is rare.

- 14** You are asked for some advice by a primary care physician who has been consulted by the parents of an 18-month-old child who recently had a series of radiographs of their leg following a fall. No fracture was visible but there is a 1 cm lesion that has been reported as a non-ossifying fibroma. What advice would you convey to the child's parents?
- a Need for referral due to risk of pathological fracture
  - b No need for specific treatment, spontaneous resolution is likely
  - c Should be treated with high-dose aspirin
  - d Are associated with Von Hippel-Lindau (VHL) syndrome
  - e 10% risk of malignant transformation

**14** Answer B: No need for specific treatment, spontaneous resolution is likely  
Non-ossifying fibromas are also known as fibroxanthoma, fibrous medullary defect and several other synonyms. They are found in up to 40% of children less than two years old. They are generally painless and found in shafts of long bones, mostly lower limb particularly around the knee. They tend to be eccentric within the metaphysis, mostly in the medulla. Multiple lesions have several associations; Neurofibromatosis, fibrous dysplasia, Jaffe-Campanacci syndrome. They tend to be aligned along the axis of the long bone and measure around 2 cm in length. If they are more than 3.3 cm and occupy more than half of the bone diameter, they should be observed. Mostly, these lesions spontaneously resolve.

- 36** A 17-year-old male was found to have a 3-cm lytic lesion surrounded by marked sclerosis in the distal diaphysis of his right femur. CT confirmed the presence of a nidus with matrix mineralisation and there was no suspicion of other lesions. What is the most likely diagnosis?
- a Osteoblastoma
  - b Enchondroma
  - c Giant cell tumour
  - d Ewing sarcoma
  - e Fibrous dysplasia

**36 Answer A: Osteblastoma**

Osteblastomas are clinically and histologically similar to osteoid osteoma with a nidus as a characteristic feature. Enchondromas often have multiple lytic lesions, but there is no nidus. A giant cell tumour is a trabeculated bone lesion. Fibrous dysplasia would be a possibility but the description is classical for an osteoblastoma and fibrous dysplasia more frequently affects the proximal femur.

**38 Which childhood tumour is almost exclusively located in the epiphysis?**

- a Osteosarcoma
- b Lymphoma
- c Chondroblastoma
- d Ewing sarcoma
- e Non-ossifying fibroma

**38 Answer C: Chondroblastoma**

Chondroblastomas usually occur from 5–20 years and are almost exclusively epiphyseal. Osteosarcomas and non-ossifying fibromas are usually metaphyseal. Lymphoma and Ewing sarcomas are usually diaphyseal.

**45 A 19-year-old girl presented with discomfort in her left leg of gradual onset with no history of trauma. A radiograph showed a translucent area with a thin sclerotic rim in the epiphysis of her left femur. An MRI was subsequently performed to further characterise this lesion and showed a lobulated margin of low signal intensity corresponding to the sclerotic margin on the X-ray. What is the most likely diagnosis?**

- a Clear cell chondrosarcoma
- b Chondroblastoma
- c Osteosarcoma
- d Fibrosarcoma
- e Osteoma



**45 Answer B: Chondroblastoma**

Chondroblastoma typically occur in this age group and are epiphyseal, well-defined lucencies with a thin sclerotic rim. Osteosarcoma, fibrosarcoma and clear cell chondrosarcoma would be expected to have more aggressive features. Osteomas occur in the elderly population and tend to be sclerotic.

- 47** A 12 year old was shown to have an eccentric, lobulated lesion involving the cortex and medulla of the proximal tibial metaphysis with a sclerotic endosteal border but no periosteal reaction. A subsequent CT showed no soft-tissue extension or fluid levels. What is the most likely diagnosis?
- a Aneurysmal bone cyst
  - b Enchondroma
  - c Chondrosarcoma
  - d Polyostotic fibrous dysplasia
  - e Chondromyxoid fibroma

**47 Answer E: Chondromyxoid fibroma**

The proximal tibial metaphysis is a classic location for a chondromyxoid fibroma which is always benign, hence there is a lack of periosteal reaction and soft-tissue involvement. Aneurysmal bone cysts do occur in the metaphysis; usually a thinned cortex and fluid-fluid levels are visible.

- 48** An 11-year-old boy with hip pain was found to have an osteoid osteoma of his right neck of femur. What is the most appropriate treatment of this lesion?
- a Chemotherapy
  - b Resection and prosthetic replacement
  - c Percutaneous radiofrequency ablation (RFA)
  - d Low-dose focal irradiation (800 cGy)
  - e Curettage, cryotherapy and bone grafting

**48 Answer C: Percutaneous radiofrequency ablation**

Percutaneous RFA is the treatment of choice for osteoid osteoma and primary success rates of up to 90% are reported. With secondary recurrence, repeat RFA leads to an even higher success rate approaching 100%. Chemotherapy and irradiation are not indicated in the treatment of these tumours. Resection, curettage, cryotherapy, bone grafting and prosthetic replacement are invasive with a greater risk of incomplete excision.

- 49** A patient presented with a long history of pain in her wrist and no history of trauma. A radiograph showed a sharply margined lesion with multiple foci of 'popcorn'-like calcification. Bone densitometry was within normal limits. An MRI showed hypointensity to muscle on both T1- and T2-weighted images and no fluid collections. What is the most likely diagnosis?

- a Fibrous dysplasia
- b Osteogenesis imperfecta
- c Multiple enchondromas
- d Calcifying solitary bone cyst
- e Aneurysmal bone cyst

**49 Answer A: Fibrous dysplasia**

The popcorn-shaped calcifications are cartilage-producing nodules, which are typical of fibrous dysplasia.

- 51** A mildly expansile lytic lesion was noted in the femur of an otherwise well 14-year-old boy. This was well defined and unilocular and extended from metaphysis into diaphysis. The remaining bone was well mineralised and there were no associated aggressive features. What is the most likely diagnosis?

- a Aneurysmal bone cyst
- b Fibrous dysplasia
- c Giant cell tumour
- d Simple bone cyst
- e Brown tumour

51 Answer D: Simple bone cyst

Simple bone cysts often have prominent fluid levels. They commonly present in the second decade and are slightly expansile. Aneurysmal bone cysts have more marked expansion with fluid-fluid levels and tend to occur in an older age group. Fibrous dysplasia is unlikely as it is not an entirely lytic lesion. Giant cell tumour is lytic but often has septations. With brown tumours there is osteoclastic activity due to hyperparathyroidism, so there would usually be osteopenia.

54 A six-year-old boy was brought to the GP with his parents after sudden onset of pain in the proximal humerus. Radiographs reveal fracture through a simple bone cyst. What imaging features would be most typical?

- a Thick internal septa
- b Well-defined lucency but no sclerotic rim
- c Subarticular epiphyseal location
- d Long axis perpendicular to bone
- e Thinned cortex with mild expansion

54 Answer E: Thinned cortex with mild expansion

Simple bone cysts are fluid-filled lesions of unknown aetiology. They are most common in males in the first two decades of life and are metaphyseal lesions which migrate into the diaphysis over time. They may have thin internal septae and a thin sclerotic rim is often present.

57 A five-year-old boy was noted to have multiple hard swellings predominately around his knees, and radiographs showed multiple bony outgrowths extending laterally from the bone and pointing away from the nearest joint. The overlying cortex remained in continuity with the native bone although there were some modelling deformities associated with the lesions. What are the individual lesions?

- a Osteosarcoma
- b Osteochondroma
- c Chondroblastoma
- d Chondrosarcoma
- e Ivory osteoma

**57 Answer B: Osteochondroma**

Diaphyseal aclasis is the condition of multiple hereditary osteochondromas. It is an autosomal dominant disorder in which multiple osteochondromas are seen throughout the skeleton, preferentially affecting the long bones. It is associated with short stature and asymmetrical growth leading to deformities.

- 58** A 16-year-old female was investigated for a lucent lesion in her spine and a primary bone tumour was suspected. As part of the work-up a three-phase bone scan was performed and the lesion of interest showed high activity in the blood-pool phase. What is the most likely diagnosis?
- a Chondroma
  - b Simple bone cyst
  - c Aneurysmal bone cyst
  - d Chondromyxoid fibroma
  - e Enostosis (bone island)

**58 Answer C: Aneurysmal bone cyst**

An aneurysmal bone cyst is very vascular hence exhibits increased uptake in the blood-pool phase. A simple bone cyst has no uptake. An enostosis has no uptake.

- 61** Which statement best describes the characteristics of a chondromyxoid fibroma?
- a Geographic bone destruction with periosteal reaction
  - b Poorly defined lesion with no sclerotic rim and septation
  - c Geographic bone destruction with no sclerotic rim
  - d Poorly defined lucency with periosteal reaction and expansions
  - e Geographic bone destruction with a prominent sclerotic rim

**61 Answer E: Geographic bone destruction with a prominent sclerotic rim**

No periosteal reaction is present unless there is a fracture. Internal septation is common and there is often thinning of the overlying cortex.

**62** At what age does a chondroblastoma usually present?

- a 0–5 years
- b 10–20 years
- c 30–40 years
- d 50–60 years
- e Over 70 years

**62** Answer B: 10–20 years

Chondroblastomas present as a well-defined lucency usually in the femur, proximal humerus or proximal tibia. Internal calcification is visible in 60% and there is usually florid marrow oedema on MRI.

**63** How are enchondromas most likely to present?

- a Anaemia
- b Fever
- c Malaise
- d Malignant degeneration
- e Pathologic fracture

**63** Answer E: Pathologic fracture

Malignant degeneration is rare, particularly in solitary peripheral lesions. It is more common with multiple lesions and in more central lesions. Unless it occurs no systemic symptoms occur.

**36** A 17-year-old female noticed pain and swelling around her distal thigh, particularly while exercising. She had no history of trauma. On examination there was localised tenderness above her knee. Radiographically, a lytic expansile lesion in the metaphysis of the distal femur surrounded by a very thin rim of cortex was visible. There was no periosteal reaction. What is the most likely disease process?

- a Ewing sarcoma
- b Osteosarcoma
- c Fibrous dysplasia
- d Aneurysmal bone cyst
- e Chondrosarcoma

36 Answer D: Aneurysmal bone cyst

The absence of periosteal reaction and presence of intact cortex make Ewing sarcoma, osteosarcoma or chondrosarcoma unlikely. Fibrous dysplasia is possible but the appearance and location would be atypical. The major differential is a giant cell tumour.

- 40 A 21-year-old man presented with pain in his knee following a fall and a radiograph demonstrated a bone tumour in his patella. What lesion is most likely?
- a Osteosarcoma
  - b Osteochondroma
  - c Chondroblastoma
  - d Non-ossifying fibroma
  - e Adamantinoma

40 Answer C: Chondroblastoma

The patella is considered an epiphyseal equivalent and hence the same differential applies. Osteosarcomas, osteochondromas and non-ossifying fibromas are metaphyseal lesions. Adamantinomas are diaphyseal.

- 41 A 14-year-old female presented with arm pain with no history of trauma and was found to have an eccentric non-expansile lucent lesion in her proximal humerus. There was no soft tissue mass or periosteal reaction and a subsequent MRI showed multiple fluid-fluid levels. What is the most likely diagnosis?
- a Giant cell tumour
  - b Aneurysmal bone cyst
  - c Enchondroma
  - d Osteoblastoma
  - e Fibrous dysplasia

41 Answer B: Aneurysmal bone cyst

The appearance of fluid-fluid levels on MRI is characteristic and the appearance given on plain film is typical.



- 43 A 30-year-old man was found to have monostotic fibrous dysplasia affecting his humerus. Which part of the bone is more likely to be involved?
- a Epiphyseal
  - b Epiphyseal and metaphyseal
  - c Metaphyseal
  - d Metaphyseal and diaphyseal
  - e Diaphyseal

43 Answer E: Diaphyseal

- 47 A 27-year-old female with a long-standing history of back pain was found to have a scoliosis. A plain radiograph demonstrated the absence of the right pedicle of T9 and a bone scan showed a hot spot at this site. CT confirmed a lytic expansile lesion with an associated soft-tissue mass. Biopsy showed the lesion to be benign and as the patient declined treatment, follow-up showed slow growth. What is the most likely diagnosis?
- a Aneurysmal bone cyst
  - b Osteoblastoma
  - c Osteoid osteoma
  - d Chondromyxoid fibroma
  - e Langerhans cell histiocytosis

47 Answer B: Osteoblastoma

Osteoblastoma, in contrast to many other benign bone lesions, are frequently associated with an extra-cortical mass.

- 48 A 12-year-old boy presented with pain in his thigh for a period of three weeks, which is worse at night and relieved by aspirin. Radiographs showed a small lucent area in the proximal femoral cortex surrounded by sclerosis. What is the most likely diagnosis?
- a Osteochondroma
  - b Eosinophilic granuloma
  - c Multiple myeloma
  - d Enchondroma
  - e Osteoid osteoma

48 Answer E: Osteoid osteoma

This is a typical description of an osteoid osteoma with a central nidus.

- 49 A nine-year-old girl with past history of cyclical vaginal bleeding presented with an eight-month history of hip and ankle pain. Multiple hyperpigmented skin lesions (café au lait spots) were seen on examination. Plain radiographs showed several 'ground-glass' lesions in the proximal femur and distal tibia. What is the most likely diagnosis?
- a Paget's disease
  - b Hand-Schüller-Christian disease
  - c Gardner's syndrome
  - d Letterer-Siwe disease
  - e McCune-Albright syndrome

49 Answer E: McCune-Albright syndrome

McCune-Albright syndrome is the triad of fibrous dysplasia, café au lait spots and endocrine dysfunction. Bone lesions in fibrous dysplasia typically have a 'ground-glass' appearance. Hand-Schüller-Christian disease is the triad of exophthalmos, diabetes insipidus and lytic skull lesions. In Gardner's syndrome there are multiple neoplasms of bone and intestinal polyps. Letterer-Siwe disease is a severe form of histiocytosis X.

- 50 A 25-year-old man presented with a painful leg following a fall playing football. A radiograph showed a pathological fracture of his femur through a well-defined, lytic lesion in the medulla, which was mildly expansile and with a ground-glass matrix. Other than at the fracture there was no disruption of the cortex or soft-tissue mass. What is the most likely diagnosis?
- a Fibrous dysplasia
  - b Metastasis
  - c Multiple myeloma
  - d Lymphoma
  - e Maffucci's syndrome

**50** Answer A: Fibrous dysplasia

Fibrous dysplasia typically has a ground-glass appearance, a thick sclerotic border and often presents as a result of a pathological fracture.

**52** An X-ray of a 32-year-old gentleman shows a subarticular multiloculated, lytic lesion in the wrist with minimal expansile modelling centred in the metacarpophalangeal joint. What is the most likely diagnosis?

- a Aneurysmal bone cyst
- b Enchondroma
- c Intraosseous ganglion
- d Unicameral bone cyst
- e Giant cell tumour

**52** Answer E: Giant cell tumour

These are typical findings of a GCT and the age of the patient is also typical. Aneurysmal bone cysts tend to cause more expansion and to be more diaphyseal. Unicameral bone cyst (also known as simple bone cyst), can be mildly expansile but not multiloculated.

**42** A 26-year-old woman was found to have a suspected giant cell tumour in her proximal humerus. What is the most appropriate management?

- a Biopsy and surgical curettage, no follow-up required
- b Biopsy, 'extended' curettage and packing with follow-up X-rays
- c Curettage alone
- d Biopsy with follow up X-rays
- e Conservative management

**42** Answer B: Biopsy, 'extended' curettage and packing with follow-up X-rays

A biopsy is usually performed to confirm the diagnosis and exclude malignancy. Extended curettage is then performed to reduce the risk of recurrence (approx 30%).

- 54 A middle-aged female presented with insidious onset of pain in her left ring finger and no history of trauma. A radiograph showed a solitary well-circumscribed, round lytic lesion with cortical expansion in the diaphysis of the middle phalanx. There is no associated soft-tissue mass. What is the most likely diagnosis?
- a Enchondroma
  - b Chondrosarcoma
  - c Medullary bone infarction
  - d Osteoid osteoma
  - e Eosinophilic granuloma

54 Answer A: Enchondroma

The description is typical. The risk of malignant degeneration in solitary peripheral enchondromas is very small.

- 56 A 28-year-old gentleman was known to have a lytic lesion in the metaphysis of his proximal tibia and underwent an MRI scan for further assessment. This showed a well-defined lesion with low signal intensity on both T1- and T2-weighted scans. What is the most likely diagnosis?
- a Intraosseous ganglion
  - b Clear cell chondrosarcoma
  - c Giant cell tumour
  - d Solitary subchondral cyst
  - e Brodie's abscess

56 Answer C: Giant cell tumour

Giant cell tumours are metaphyseal lesions that extend to the articular surface. They are most common in the third and fourth decades of life. The low signal intensity on T1- and T2-weighted images seen with giant cell tumours is due to haemosiderin deposition. All the other diagnoses have high signal intensity on T2-weighted images.

- 58 A nine-year-old girl presented with left hip and knee pain. A subtle well-defined radiolucency was visible in the basi-cervical region of the left femur measuring 6mm and within this lesion there was a smaller dense opacity. Extensive cortical sclerosis was present around the lesion. What is the most likely diagnosis?
- a Osteoblastoma
  - b Chronic sclerosing osteomyelitis
  - c Foreign body granuloma
  - d Subperiosteal haematoma
  - e Osteoid osteoma

58 Answer E: Osteoid osteoma

The appearance of a central nidus with surrounding sclerosis is common. Osteoblastoma tends to have irregular margins and is larger (2–10 cm). Chronic sclerosing osteomyelitis is also usually irregular with more bone destruction and periosteal reaction although it is possible to mistake a sequestrum for the nidus.

- 62 An 18-year-old female presented with hip pain and was found to have a well-defined lesion in her greater trochanter, which was ultimately proven to be a chondroblastoma. What pattern of mineralisation is typical?
- a Normal surrounding bone, no mineralisation in lesion
  - b Normal surrounding bone, rings and arcs within lesion
  - c Surrounding sclerosis, no mineralisation in lesion
  - d Surrounding osteopenia, dense sclerosis within lesion
  - e Surrounding osteopenia, popcorn-shaped densities within lesion

62 Answer B: Normal surrounding bone, rings and arcs within lesion

- 5 A seven-year-old boy who is known to have Ollier's disease presents with a solid lump close to his knee. What radiological finding is likely?
- a Cartilaginous rest
  - b Endosteal reaction
  - c Haemangioma
  - d Lymphangioma
  - e Bony spurs pointing away from the joint

5 Answer A: Cartilaginous rest

Cartilaginous rests are round radiolucencies, caused by displaced cartilage in the bone. An enchondroma is a benign cartilaginous lesion. Enchondromatosis, also known as Ollier's disease, is due to derangement of cartilaginous growth, leading to migration of cartilaginous rests from the epiphysis to the metaphysis, where proliferation occurs. It is usually diagnosed in childhood and, in addition to abnormal growth, it is associated with juvenile granulosa cell tumours of the ovary. The main complication is sarcomatous transformation, which is more common in axial rather than appendicular enchondromas. Maffucci's syndrome is similar except that it also involves haemangiomas and lymphangiomas.

- 15 A 60-year-old patient with hip pain was assessed with a radiograph of their pelvis. Small lucent lines at right angles to the cortex on the medial border of the proximal femoral shaft were visible bilaterally. What would be the most likely underlying diagnosis?
- a Osteoporosis
  - b Fibrous dysplasia
  - c Hyperthyroidism
  - d Intraosseous desmoid
  - e Achondroplasia



15 Answer B: Fibrous dysplasia

There are at least 10 causes but the four most common are: osteomalacia, fibrous dysplasia, osteogenesis imperfecta, Paget's. Pseudofractures are the same as Looser lines or osteoid seams, and are insufficiency fractures and non-union. They occur at sites of mechanical stress such as where vessels enter bone. They tend to be bilateral and symmetric at right angles to the bone margin. The pathognomonic sign is a 2–3 mm stripe of lucency at right angles to the cortex (osteoid seam).

- 38 A 30-year-old man is found to have an incidental abnormality in his distal femur after a radiograph was performed to investigate a skiing injury. This is a 4-cm well-defined lucent lesion at the lateral margin of the distal end of the femur abutting the articular surface without expansion. What is the most likely diagnosis?

- a Aneurysmal bone cyst
- b Enchondroma
- c Osteoblastoma
- d Giant cell tumour
- e Osteochondroma

38 Answer D: Giant cell tumour

Giant cell tumours are almost invariably epiphyseal although they may extend to involve the metaphysis. They occur almost exclusively in those with closed epiphyses and are eccentric with a non-sclerotic margin.

- 40 A 24-year-old university student is awaiting treatment of a chondromyxoid fibroma in his proximal tibia when he presents to a different hospital with an incidental injury to his leg. No fracture is visible but what is the expected appearance of this tumour?

- a Well-defined lucent lesion with a non-sclerotic margin in the epiphysis
- b Well-defined lucent lesion with sclerotic rim in the metaphysis
- c Poorly defined lucent lesion in the diaphysis
- d Poorly defined lucent lesion in the epiphysis
- e Poorly defined lucent lesion in the metaphysis

40 Answer B: Well-defined lucent lesion with sclerotic rim in the metaphysis  
Chondromyxoid fibromas generally occur between the ages of 10 and 30 years  
Internal calcification is uncommon.

- 41 A 19-year-old female presented with lower back pain and a lumbosacral X-ray showed an expansile lytic lesion in the right sacrum. The margins were well defined and there was no soft-tissue mass visible. No other lesions were suspected. What is the most likely diagnosis?
- a Multiple myeloma
  - b Osteoid osteoma
  - c Chordoma
  - d Giant cell tumour
  - e Aneurysmal bone cyst

41 Answer D: Giant cell tumour (GCT)

GCTs are characteristically well defined with a non-sclerotic margin and are most frequently seen in young adults aged between 20 and 40 years. Most GCTs occur in the long bones, but a number do occur in the spine where they tend to affect younger patients and to be three to four times more common in the sacrum than rest of spine.

- 42 A 25-year-old man was found to have a giant cell tumour in his tibia. What location in the bone is most typical?
- a Epiphyseal
  - b Epiphyseal and metaphyseal
  - c Metaphyseal
  - d Metaphyseal and diaphyseal
  - e Diaphyseal

**42 Answer A: Epiphyseal**

Giant cell tumours are usually epiphyseal in a sub-articular location but may

extend from the epiphysis to involve the metaphysis. Ninety-seven per cent occur after closure of the epiphyses.

- 45** A 20-year-old man slowly developed predominantly nocturnal low back pain. He reports that salicylate-based medication is particularly helpful in relieving his pain. What is the most likely diagnosis?

- a Fibrosarcoma
- b Malignant fibrous histiocytoma
- c Osteoid osteoma
- d Chondrosarcoma
- e Ollier's disease

**45 Answer C: Osteoid osteoma**

Osteoid osteoma is a benign bone tumour composed of osteoid and woven bone that usually affects young individuals. They are small tumours (less than 2 cm in diameter) with a central nidus in which prostaglandin E<sub>2</sub> is elevated. This has been suggested to be the cause of the pain experienced and explains the typical history of relief with salicylates.

- 46** A man attended a physiotherapy clinic for treatment of long-standing lower back pain. There is no history of trauma and the physiotherapist noted that the patient was systemically well. As he was not improving, a radiograph was requested, which showed a lesion in L4. Which feature would support the diagnosis of an osteoblastoma over another diagnosis?

- a Location in the posterior elements
- b Patient age under 30
- c Absence of a sclerotic rim
- d Less than 2-cm diameter
- e Cortical disruption

**46 Answer A: Location in the posterior elements**

An osteoblastoma is histologically identical to an osteoid osteoma but usually larger and the classical description is of a well-defined expansile lesion in the posterior elements of the spine. Around 80% of cases present before 30 years of age and a sclerotic rim is usually present. There is, however, a wide variety of possible appearances including cortical thinning and a soft-tissue mass which can resemble a malignant process.

- 47** An 11-year-old boy presented with left-sided groin pain and recent weight loss. He had been finding it particularly difficult getting in and out of the car when going to school. His mother had been giving him aspirin that helped initially but this no longer had much of an effect. Plain radiographs revealed a 9-mm well-circumscribed lesion with a sclerotic border and central radiolucent nidus within the femoral neck. What is the most likely diagnosis?
- a Aneurysmal bone cyst
  - b Fibrous dysplasia
  - c Stress fracture of the femoral neck
  - d Brodie's abscess
  - e Osteoid osteoma

**47 Answer E: Osteoid osteoma**

The femoral neck is the most common location for osteoid osteomas.

- 48 A 34-year-old man presented with a two-month history of pain in his right knee. On examination his right knee was enlarged and tender. A radiograph showed a 9-cm lytic lesion in the epiphysis of the distal femur with a 'soap bubble' appearance. A biopsy showed multinucleated cells in a stroma with spindle-shaped mononuclear cells. What is the most likely diagnosis?
- a Tuberculosis
  - b Giant cell tumour
  - c Osteosarcoma
  - d Chondrosarcoma
  - e Malignant fibrous histiocytoma

48 Answer B: Giant cell tumour

Giant cell tumours are typically epiphyseal and the 'soap bubble' appearance is characteristic. More destruction would be expected with the other options.

- 49 A bone scan of a 17 year old shows a 'double-density' sign in the femoral neck with a focal centralised region of intense activity surrounded by a region of lesser activity. What is the most likely cause?
- a Brodie's abscess
  - b Simple bone cyst
  - c Bone infarction
  - d Osteoid osteoma
  - e Stress fracture of femoral neck

49 Answer D: Osteoid osteoma

Osteoid osteoma has a typical double-density sign of a nidus with surrounding activity due to the reactive sclerosis. With a stress fracture of the femoral neck it is unusual to see the double-density sign. Brodie's abscess usually has a more uniform pattern of radiotracer uptake. A simple bone cyst has no uptake on a bone scan.

- 50 A patient with a known area of fibrous dysplasia in their femur subsequently presented with a soft tissue mass in their thigh and an MRI was arranged.
- The mass was of low signal on T1- and high signal on T2-weighted images and a biopsy showed it to be a myxoma. What is the likely diagnosis?
- a Mazabraud's syndrome
  - b Ollier's syndrome
  - c Maffucci's syndrome
  - d Metastatic malignancy
  - e Gardner's syndrome

50 Answer A: Mazabraud's syndrome

Mazabraud's syndrome is the rare association of fibrous dysplasia with intramuscular myxoma and is an important differential for a soft-tissue mass with lytic bone lesions.

- 55 A six-year-old boy was brought to the Emergency Department after falling from a climbing frame. A radiograph showed a fallen fragment within a well-defined unilocular lesion in the proximal humeral metaphysis. There was cortical thinning but no periosteal reaction. What is the most likely underlying diagnosis?
- a Osteitis deformans
  - b Engelmann's disease
  - c Fibrous dysplasia
  - d Simple bone cyst
  - e Osteoid osteoma

55 Answer D: Simple bone cyst



- 56 A radiograph of a 16 year old shows a well-defined lytic lesion with a thin sclerotic margin in the epiphysis of the proximal tibia. On MRI, STIR and T2-weighted images demonstrate a high signal, lobulated lesion with a thin low signal margin. Extensive surrounding bone oedema is seen. What is the most likely diagnosis?
- a Aneurysmal bone cyst
  - b Giant cell tumour
  - c Chondrosarcoma
  - d Chondroblastoma
  - e Brodie's abscess

56 Answer D: Chondroblastoma

Chondroblastomas are usually spherical, well-defined lesions in an epiphyseal location and with a fine sclerotic margin. Florid marrow oedema surrounding the lesion is also a typical feature. Aneurysmal bone cysts have a low signal rim on both T1- and T2-weighted MRI images but bone marrow oedema is not typical. Giant cell tumours are rare in children and their margins are not sclerotic. Chondrosarcomas are epiphyseal but rare in this age group.

- 57 A 15-year-old patient felt a lump on their hand and a radiograph demonstrated an enchondroma. From which part of the bone do enchondromas develop?
- a Epiphysis
  - b Epiphysis and metaphysis
  - c Metaphysis
  - d Metaphysis and diaphysis
  - e Diaphysis

57 Answer C: Metaphysis

Enchondromas are metaphyseal, although they may affect the epiphysis after closure of the growth plate.

62 Where in the body are enchondroma most likely to occur?

- a Femur
- b Humerus
- c Metacarpals
- d Ribs
- e Tibia

62 Answer C: Metacarpals

The majority occur in the small tubular bones of the hand.

63 At what age is an osteoid osteoma most likely to present?

- a 0–10 years
- b 10–30 years
- c 30–50 years
- d 50–70 years
- e Over 70 years

63 Answer B: 10–30 years

Three-quarters will be within this range.

5. A 25-year-old man presents with a 4-month history of increasing dull lower back ache. He is otherwise systemically well. He has no neurological signs. An x-ray of the lumbar spine demonstrates a slight scoliosis, with an enlarged sclerotic left pedicle of L3. A subsequent CT scan shows a 3-cm lucent focus within the left pedicle of L3, which has expanded the bone. There is surrounding sclerosis. What is the most likely underlying diagnosis?

- A. Osteoid osteoma.
- B. Enostosis.
- C. Osteoblastoma.
- D. Osteomyelitis.
- E. Intracortical haemangioma.

### 5. C. Osteoblastoma.

Osteoblastoma is similar both clinically and histologically to osteoid osteoma, but there are some differences that aid in distinguishing these two entities. Clinically osteoblastoma is typically less painful than osteoid osteoma and does not respond as well to salicylates. An osteoblastoma in the neural arch of the spine is more likely to cause neurological signs, as these lesions are typically larger and more expansile than osteoid osteoma. The lucent nidus seen in osteoid osteoma is usually less than 1.5–2 cm in size, whereas the nidus in osteoblastoma is usually larger than 2 cm at diagnosis and has less surrounding sclerosis. The nidus may or may not have a calcific focus within, in both these diagnoses. The appearance described in the question is the subgroup of osteoblastoma that has similar features to osteoid osteoma. Other appearances on imaging of osteoblastoma include an expansile lesion with multiple small calcifications and a peripheral sclerotic rim or, more rarely, an aggressive appearance with osseous expansion, bone destruction, infiltrating soft tissue, and intermixed matrix calcification.

An enostosis (or bone island) may be giant (greater than 2 cm), but should be well defined and densely sclerotic. It is possible a bone abscess could cause a lytic lesion with surrounding sclerosis, but the patient is systemically well, making infection less likely. A bone abscess is also unlikely to be as expansile as the lesion described. Intracortical haemangioma is a very rare diagnosis, usually within the cortex of a long bone, such as the tibia. On CT there is a hypoattenuating lesion, with spotty internal calcification or a 'wire-netting' appearance.

**6. A 35-year-male presents with pain in the thigh. A plain radiograph reveals an eccentric expansile lucent lesion without a sclerotic margin but with a narrow zone of transition in the distal femoral metaphysis and epiphysis, which extends to the joint surface. What is the most likely diagnosis?**

- A. Osteosarcoma.
- B. Giant cell tumour (GCT).
- C. Metastasis.
- D. Aneurysmal bone cyst.
- E. Fibrous dysplasia.



**6. B. Giant cell tumour (GCT).**

This is the classical description and location of a GCT. They occur age 20–40 years, in the long bones and occasionally the sacrum and pelvis. They are lucent, eccentric, and expansile but do not usually produce sclerosis and produce a periosteal reaction in less than a third of patients. They may have a multiloculated appearance. They originate in the metaphysis but extend to the subchondral surface in the skeletally mature. MRI often reveals fluid–fluid levels and some low signal on T2WI due to haemosiderin or collagen deposition. The major differential diagnosis is an aneurysmal bone cyst (ABC), but this classically has a sclerotic margin and usually occurs under 30 years of age (75% occur before the age of 20 years). Fibrous dysplasia would usually present at a younger age in the metaphysis with extension into the diaphysis; a trabeculated/ground-glass appearance is typical with a thick sclerotic margin and endosteal scalloping. Metastasis would be relatively rare at this age and there is no mention of a primary tumour. Osteosarcoma would have a more aggressive appearance with a wide zone of transition, periosteal reaction, cortical destruction, and soft tissue extension.

**23. A 16-year-old boy fell playing football and hurt his left knee. He has some difficulty weight-bearing and presents to the A&E department. An x-ray of his left knee is performed. This demonstrates a small joint effusion, but no fracture is seen. An approximately 3-cm diameter, well-defined lucent bony lesion, with a thin sclerotic margin, is identified within the proximal epiphysis of the tibia. No internal calcification is evident on plain x-ray. What is the most likely diagnosis for this abnormality?**

- A. Chondromyxoid fibroma.
- B. Enchondroma.
- C. GCT.
- D. Chondroblastoma. ✓
- E. Chondrosarcoma.

**23. D. Chondroblastoma.**

These are radiolucent lesions that typically occupy the epiphysis of long bones in younger people, usually before skeletal maturity. They tend to be less than 4 cm in size, with approximately three-quarters having a sclerotic border and one-third a calcified matrix seen on plain radiographs.

Chondromyxoid fibromas are rare benign tumours occurring in predominantly the second and third decades of life. They characteristically have sclerotic margins and appear lobulated or 'bubbly'. They usually arise in the metaphysis of long bones with occasional diaphyseal extension.

GCTs tend to occur in young adulthood following skeletal maturity. Patients usually present with pain. The lesion is purely lytic, typically with well-defined, but non-sclerotic, margins. When present in long bones, the lesions are typically metaphyseal, extending across a fused epiphysis to a subarticular location. Periosteal reaction is atypical, but expansile remodelling, cortical penetration, and soft-tissue extension may be seen.

**28. A 35-year-old man sprains his right ankle and attends the A&E department. An x-ray of the right ankle is performed. This does not show any evidence of a fracture, but the lateral view does demonstrate a well-defined radiolucent lesion with a faint sclerotic margin in the mid calcaneus. There is some central calcification within the lesion. What is the most likely diagnosis?**

- A. Simple bone cyst.
- B. Normal variant.
- C. Enchondroma.
- D. Intraosseous lipoma.
- E. Bone infarct.

**28. D. Intraosseous lipoma.**

This is usually asymptomatic and discovered as an incidental finding in adults between 30 and 60 years. The calcaneus is the most common site for intraosseous lipoma, accounting for approximately 32% of cases. The key radiographic features are as described. The central dystrophic calcification seen in approximately 62% of cases is considered pathognomic.

The major differential diagnosis of this lesion is a simple bone cyst, although this would not contain central calcification. Unlike bone cysts elsewhere, it is seen at this site into adulthood. Also within the differential diagnosis is a pseudolesion within the calcaneus, caused by a relative paucity of trabecular bone at the same location. Again, central calcification would not be a feature in this phenomenon.

Enchondroma is typically a well-defined osteolytic lesion with central calcification, but it usually has a predilection for tubular bones and would be exceedingly rare in the calcaneus. The described appearances are not typical for bone infarct.

**40. The case of a 22-year-old male with typical clinical and radiographic features of osteoid osteoma is discussed at the musculoskeletal multidisciplinary team meeting regarding treatment planning. A decision is made to offer radiofrequency ablation (RFA). You have been asked to consent the patient for the procedure. Which of the following statements is true?**

- A. Up to six repeat procedures may be required.
- B. It is performed under local anaesthetic.
- C. Biopsy is necessary to confirm diagnosis prior to treatment.
- D. Complete symptom relief is seen in 90% after initial therapy.
- E. RFA treatment of vertebral osteoid osteomas is contraindicated.



**40. D.** Complete symptom relief is seen in 90% after initial therapy.

Osteoid osteoma is a benign, but painful, bone tumour typically found in the lower limbs of children and young adults. The use of CT-guided RFA is considered to be a safe and effective technique and is considered to be the treatment of choice over open surgical approaches. Complete relief of symptoms is observed in approximately 90% after initial therapy and is reported up to 100% for secondary procedures. The procedure is performed under general or spinal anaesthesia. A typical clinical history of night pain relieved by non-steroidal analgesia and radiographic features of the central nidus are considered sufficiently diagnostic to proceed with RFA. The procedure should not be performed if there are doubts regarding diagnosis. Osteomas within the spine are potentially treated by RFA if the nidus is >1 cm from the dura/neural structures. Since most spinal osteomas are located within the posterior elements, however, RFA is generally unsuitable.

**43. A 16-year-old boy presents with a slowly enlarging, painful swelling in his left lateral chest wall. A CXR shows an expansile lucent lesion arising from the lateral aspect of the left seventh rib. An MRI scan is performed for further evaluation and this demonstrates a lobulated, thin-walled multiseptated lesion with fluid–fluid levels, the dependent layer of which are hyperintense on T1WI. What is the most likely diagnosis?**

- A. Fibrous dysplasia.
- B. Aneurysmal bone cyst.
- C. Enchondroma.
- D. Chondroblastoma.
- E. Cystic angiomatosis.

**43. B.** Aneurysmal bone cyst.

ABC accounts for approximately 5% of primary rib lesions, excluding myeloma. The radiological findings and age described in the question are classical for this lesion. Approximately 75% of patients are <20 years of age. The key findings on MRI are the fluid–fluid levels due to the settling of degraded blood products within the cysts. Fluid–fluid levels may also be a feature of other lesions, including GCT and chondroblastoma, but the thin, well-defined margins of an ABC should help to distinguish it from other lesions, particularly in this young age group.

Fibrous dysplasia is the most common benign rib lesion. The radiographic appearances are variable, but may show unilateral fusiform enlargement and deformity with cortical thickening and increased trabeculation of one or more ribs. The matrix may appear lytic, may demonstrate a ground-glass appearance, or rarely be sclerotic. Amorphous or irregular calcifications may be seen within the lesion on CT, and MRI shows low to intermediate signal on T1WI and variable T2WI signal.



Enchondromas more typically arise in the anterior cartilaginous portion of the rib. Radiographs reveal a lobulated, well-demarcated osteolytic lesion that demonstrates mild expansion and well-defined, sclerotic margins. There is typically matrix calcification and CT is more sensitive at detecting this when the calcification is subtle. MRI shows T2WI hyperintense foci that appear to coalesce with one another and reflect the high fluid content of hyaline cartilage.

Chondroblastoma of a rib is reported in the literature, but would be exceedingly rare and typically occurs in the epiphyses of long bones. Cystic haemangiomatosis is a rare disease of disseminated multifocal haemangiomatous or lymphangiomatous lesions in the skeleton and is usually an incidental asymptomatic finding.

**66. A 5-year-old boy presents with a history of walking difficulty. On examination he is noted to have an antalgic gait and lower limb length discrepancy, with the right limb being shorter than the left. Plain radiographs of the right leg show lobular ossific masses arising from the distal femoral epiphysis and the talus, which resemble osteochondromas. What is the most likely underlying diagnosis?**

- A. Dysplasia epiphysealis hemimelica (Trevor disease).
- B. Multiple epiphyseal dysplasia.
- C. Diaphyseal aclasis.
- D. Dyschondrosteosis (Leri–Weil disease).
- E. Klippel–Trenaunay–Weber syndrome.

**66.A.** Dysplasia epiphysealis hemimelica (Trevor disease).

This is an uncommon developmental disorder relating to the formation of an osteochondroma-type lesion at the epiphyses of usually a single lower extremity. The epiphyses most commonly involved are those on either side of the knee or ankle. Typically it is only the medial or lateral side of the epiphyses affected (medial:lateral 2:1). The disease is usually recognized at a young age because of an antalgic gait, palpable mass, varus or valgus deformity, or limb length discrepancy.

- 1 A plain radiograph reveals a well-defined lucent lesion within the metaphysis and epiphysis of the distal femur. There is eccentric expansion and the cortex is thin but intact. It does not reach the articular surface. CT reveals fluid-fluid levels.

Which of the following is the most likely cause?

- (a) Giant cell tumour
- ✓ (b) Aneurysmal bone cyst } both have fluid-fluid level
- (c) Enchondroma
- (d) Non-ossifying fibroma
- (e) Chondromyxoid fibroma

1 (b)

Of the conditions that typically cause lucent, eccentrically expanded lesions, only GCTs and ABCs have fluid-fluid levels on CT imaging. As GCTs do not reach the articular surface, this is most likely to be an ABC.

- 12 A 27 year old undergoes a CXR as part of an occupational assessment. The CXR shows a solitary expansile right 5th posterior rib mass. CT confirms the mass is arising from the rib and that it shows no aggressive features.

What is the likeliest diagnosis?

- (a) Exostosis of the rib
- (b) Benign cortical defect
- (c) Langerhans cell histiocytosis
- ✓ (d) Fibrous dysplasia → the commonest benign rib tumor, osteochondroma is the next common.
- (e) Osteblastoma

12 (d)

Fibrous dysplasia is the commonest benign rib tumour. Second most common is osteochondroma/bony exostosis but this typically occurs at the costochondral junction. Other benign possibilities include GCT and aneurysmal bone cyst.

- 23 A 7 year old boy is brought to the GP by his parents, having noticed soft, blue-coloured growths on his right hand. The hand X-ray reveals multiple enchondromas.

Which of the following features would confirm Maffucci's syndrome as the diagnosis rather than Ollier's disease?

- (a) A first degree relative also affected
- (b) Bilateral, predominantly symmetrical disease
- (c) A discrepancy in arm length
- (d) Sarcomatous degeneration
- (e) Soft tissue haemangiomas

23 (e)

Both conditions describe multiple enchondromas affecting the hands and/or feet, and both tend to be unilateral; neither has a genetic component. Both conditions can lead to shortening of the involved arm/leg, resulting in length discrepancy. Malignant degeneration can be to osteosarcoma (young adults), or chondro/fibrosarcoma (older patients); it is more common in Maffucci's syndrome, but is still seen in 5–30% of cases of Ollier's disease. Maffucci's syndrome describes enchondromas with additional multiple soft tissue haemangiomas, if bilateral there is marked asymmetry.

- 35 A 50 year old man presents with knee pain. Plain radiographs show an 8 cm lytic lesion within the distal femoral metaphysis with endosteal scalloping and cortical thickening. CT shows matrix mineralisation.

Which of the following features does not favour a diagnosis of chondrosarcoma over enchondroma?

- (a) The patient's age
- (b) The patient's sex
- (c) The lesion size
- (d) The lesion site
- (e) The CT findings

*favour chondrosarcoma*

*enchondroma*  
① young < 10 yr  
② female  
③ < 5cm

35 (e)

Enchondromas present in a slightly younger age group and are more common in females. They typically affect the bones of the hands and feet and are usually less than 5 cm in size. Although both lesions show matrix mineralisation, this feature is slightly commoner in enchondromas. Other features to favour chondrosarcoma over enchondroma include presentation with a mass, cortical destruction and the presence of a soft tissue mass.

39 Regarding giant cell tumours, which of the following statements is true?

- (a) GCT usually regresses during pregnancy *↑↑ is size during pregnancy*
- (b) It is a highly malignant lesion
- (c) Surgical resection is usually curative
- (d) The majority arise in the spine
- (e) Vertebral body involvement is more common than the posterior elements

39 (e)

GCTs are usually benign lesions. Malignancy occurs in 5–10% of cases and is usually secondary to previous radiation therapy. The majority of spinal lesions arise within the sacrum. Vertebral involvement accounts for only 7% of cases: thoracic spine is the most common location, followed by cervical and lumbar regions. They typically increase in size during pregnancy, thought to be due to hormonal influences. GCTs tend to be locally aggressive and complete surgical resection is uncommon; adjuvant radiotherapy is often administered. Recurrence occurs in 40–60%, and is suggested on plain film by the presence of new areas of osseous destruction.

- 47 A 40 year old man presents with heel pain. Lateral radiograph of the foot reveals a well defined 3 cm lesion located between the anterior and middle thirds of the calcaneus. The lesion is radiolucent with a thin rim of sclerosis and central calcification.

**What is the likely diagnosis?**

- (a) Desmoplastic fibroma
- (b) Giant cell tumour
- ~ (c) Intraosseous lipoma
- (d) Osteoid osteoma
- (e) Unicameral bone cyst

47 (c)

Intraosseous lipomas are rare bone tumours; they are often asymptomatic and present incidental, but can be associated with pain. The commonest locations are within the proximal femur (Ward's triangle) and in the area of the calcaneus described. In these areas there is a relative paucity of trabecular bone and it is thought that this leads to an 'overshoot' phenomenon during the transition of haematopoietic to fatty marrow, with the resultant formation of the lipoma. Central or ring calcification in a lucent lesion in this location of the calcaneus is said to be pathognomonic of an intraosseous lipoma and allows its distinction from a UBC. If clinical doubt persists MR imaging can be used for further clarification and to confirm the presence of fat.

- 48 Regarding osteoblastomas, which of the following is true?

- (a) An expansile appearance on plain film implies malignancy
- ~ (b) Matrix calcification is a common plain film feature
- (c) They result in scoliosis more commonly than osteoid osteoma
- (d) They rarely grow beyond 2 cm
- (e) They usually present in the 6th–7th decades

**48 (b)**

Osteoblastomas are uncommon primary bone tumours (< 1%). 90% occur in 2nd – 3rd decades, although cases have been documented up to 72 years. They are histologically similar to osteoid osteoma but less well organised and by definition larger (> 2 cm). The majority (30–40%) of cases occur in the spine, with a slight predominance for the posterior elements (55%). An expansile lesion in osteoblastoma is not typically associated with malignancy. Scoliosis can occur in both and is typically painful, but occurs more commonly in osteoid osteoma, where the scoliosis results from muscle spasm secondary to the inflammatory mediators produced. Osteoblastomas are not radiosensitive and surgical excision is performed in most cases, however, recurrence is seen in up to 50%.

- 19 A plain radiograph of a 20 year old's knee shows a well defined lesion in the distal femoral epiphysis. It is lytic, with a narrow zone of transition and a well defined sclerotic rim. The lesion does not reach the articular surface, and is not expansile.**

**Which of the following conditions is the most likely?**

- (a) Aneurysmal bone cyst
- (b) Chondroblastoma
- (c) Giant cell tumour
- (d) Simple bone cyst
- (e) Metastasis

**19 (b)**

Chondroblastomas almost invariably occur in the epiphyses, and 90% occur in those under 30 years old. Lesions to consider in this location and age group include: infection, chondroblastomas, GCTs and, less commonly, ABCs and eosinophilic granulomas. With regards to the other conditions mentioned: GCTs abut the articular surface; ABCs are almost always expansile; simple bone cysts are not epiphyseal; metastases are unlikely in a 20 year old.



- 23** A 15 year old girl presents with a history of several months leg pain, worse at night which is relieved by salicylates. Plain films show a 1.3 cm lesion in the proximal tibial shaft which has a round central lucency with surrounding sclerosis.

**What is the likeliest diagnosis?**

- (a) Osteosarcoma
- (b) Brodie abscess
- (c) Aneurysmal bone cyst
- (d) Osteoid osteoma
- (e) Stress fracture

**23 (d)**

The classical finding is that of a central, usually lucent nidus of less than 1.5 cm in size with varying degrees of surrounding sclerosis. There is often a typical clinical picture which enables differentiation from a Brodie abscess.

- 52** A 31 year old previously well woman presents with pain just above the knee. Plain radiographs show a fracture through a well circumscribed, expansile, solitary lytic bone lesion with a narrow zone of transition. The lesion involves the articular surface but does not extend into the joint space.

**What is the likeliest diagnosis?**

- (a) Chondroblastoma
- (b) Fibrous dysplasia
- (c) Giant cell tumour
- (d) Eosinophilic granuloma
- (e) Aneurysmal bone cyst

**52 (c)**

This is the characteristic patient age and site of GCT, where the unfused physis acts as a barrier to spread of the lesion. After fusion, extension to within 1cm of the articular surface is the commonest pattern, although transarticular spread has been reported. It can have either a 'soap bubble' like appearance or, as described here, a uniform lytic appearance. 10% present with pathological fractures.

**55 A 3 year old child of short stature is found to have numerous bony exostoses on plain radiography.**

**Which of the following statements is not true?**

- (a) Hereditary transmission is autosomal dominant
- (b) Malignant transformation to osteosarcoma occurs in 1%
- (c) The distal femur and proximal tibia are most commonly involved bones
- (d) It is more common in males
- (e) There is an association with polydactyly

**55 (b)**

Hereditary multiple exostoses (also known as diaphyseal aclasia) is an autosomal dominant condition characterised by multiple exostoses. Malignant transformation to chondrosarcoma occurs in 1–5%.

- 58 A 30 year old patient presents with multiple bilateral renal angiomyolipomas, one of which has bled. She is also found to have a giant cell astrocytoma in her brain and bilateral interstitial lower lobe fibrosis on CXR.**

**Which of the following bone lesions is most commonly associated with this condition?**

- (a) Bone cysts
- (b) Osteochondroma
- (c) Giant cell tumour
- (d) Fibrous dysplasia
- (e) Adamantinoma

**58 (a)**

The underlying condition described is tuberous sclerosis. The associated bone cysts most commonly affect the small bones of the hand. Other skeletal features include sclerotic bone islands which most commonly affect the calvarium (in 45% of cases) and also the pelvis and long bones.

- 61 A 10 year old girl presents with precocious puberty and café au lait spots. McCune-Albright syndrome is suspected.**

**Which of the following features would you not expect to see?**

- (a) A ground glass lesion in the medullary cavity of the femur
- (b) Champagne glass appearance of the pelvis
- (c) Endosteal scalloping of the femur with intervening normal cortex
- (d) Cortical expansion of the ribs
- (e) Increased uptake of a rib lesion on bone scintigraphy

**61 (b)**

McCune-Albright syndrome is a form of fibrous dysplasia. It is seen in 10% of cases. Radiologically, it is characterised by a polyostotic, unilateral pattern of involvement. The skull is commonly involved. A champagne glass appearance of the pelvis is seen in achondroplasia.

- 73 A 30 year old undergoes a shoulder x-ray following a fall. No fracture is identified. However, note is made of acromio-clavicular joint erosion.**

**Which of the following is least likely?**

- (a) Lymphoma
- (b) Hyperparathyroidism
- (c) Rheumatoid arthritis
- (d) Scleroderma
- (e) Fibrous dysplasia

**73 (e)**

Other causes include gout, myeloma, osteomyelitis and previous trauma.

- 75 A 13 year old boy presents with a long history of a dull ache in his hip. Plain radiographs show a 4cm eccentric lytic lesion of the proximal femoral epiphysis extending to involve the proximal metaphysis. It has a lobulated, well-defined sclerotic margin and areas of calcification within it. There is significant surrounding periosteal reaction.**

**Which of the following is the likeliest diagnosis?**

- (a) Enchondroma
- (b) Chondromyxoid fibroma
- (c) Chondrosarcoma
- (d) Chondroblastoma
- (e) Giant cell tumour

**75 (d)**

The main differential diagnosis for epiphyseal lesions would be GCT. However, these typically arise in a slightly older age group and only cross the physis once it has fused. Chondrosarcomas occur in an older age group (median age 45 years) and chondromyxoid fibromas are rare (usually but not exclusively metaphyseal) cartilaginous tumours arising from the cortex.

- 12) A female adult patient with right shoulder pain is shown to have multiple markedly expansile lytic lesions within the scapula and clavicle secondary to metastatic malignant spread. Which of the following is most likely to be the primary site of malignancy?
- a. renal
  - b. breast
  - c. cervical
  - d. colon
  - e. bronchus

12) a. \*\*

The common cancers that typically metastasize to bone are breast, lung, thyroid, renal and prostate. Due to the high prevalence of colon cancer, even though only a relatively small proportion metastasizes to bone, it forms a significant proportion of bone metastases. Prostatic metastases are typically sclerotic, whereas breast deposits are mixed. Colonic bone metastases are usually lytic, with renal metastases typically lytic and expansile due to their highly vascular nature. Other less frequent sources of lytic expansile metastases include thyroid, melanoma and phaeochromocytoma.

- 17) In imaging of focal bone lesions in the appendicular skeleton, which of the following radiographic features is most likely to indicate an aggressive or malignant process?
- a. cortical expansion
  - b. lytic process
  - c. periosteal reaction
  - d. multiple lesions
  - e. wide zone of transition



17) e. \*\*

The zone of transition relates to the interface between the tumour margin and the host bone. It is an extremely important discriminator, particularly for lytic lesions. Lesions with a well-defined margin (and therefore narrow zone of transition) are described as geographic and are usually non-aggressive, whereas those with a wide zone of transition are termed 'permeative' and are often malignant or aggressive (such as

in osteomyelitis). Cortical expansion without destruction is seen in many benign or slow-growing conditions such as fibrous cortical defect and aneurysmal bone cyst. Many bone lesions, both benign and aggressive, are lytic. Periosteal reaction does not indicate an aggressive lesion as such, but the pattern of reaction can do so. Multiplicity is not an indicator of malignancy, as it can be seen in benign and self-limiting processes (such as multiple enchondromatosis and neurofibromatosis). Equally, a solitary lesion may be malignant.

19) The presence of punctate, ring-like or arcuate calcification in a lytic bone lesion on plain radiography is most commonly associated with which of the following matrix types?

- a. osteoblastic
- b. fibrous
- c. cartilaginous
- d. cellular
- e. mixed

19) c. \*\*

Chondroid tumour matrix may or may not calcify, but, if it does, the pattern is characteristically in arcs or circles and is sometimes described as 'popcorn'. Osteoid matrix when calcified is usually dense and homogeneous like a cloud. Calcified fibrous matrix has a characteristic ground-glass appearance, whereas a cellular tumour usually does not show matrix calcification. A mixed matrix will show mixed characteristics.

24) Of the following types of periosteal reaction, select the one most likely to indicate a benign process?

- a. soap-bubble
- b. sunray
- c. hair-on-end
- d. laminated
- e. Codman's triangle

24) a. \*\*

Periosteal reactions are usually a radiographic manifestation of underlying bone disease. The term 'soap bubble' refers to expansion of the cortex without destruction by a lytic bone lesion. The intact cortex usually indicates a benign process, whereas cortical destruction is associated with malignant or aggressive lesions. Sunray and hair-on-end reactions are spiculated forms of periosteal reaction that occur following periosteal elevation by tumour, with tumour preventing the subperiosteal space from filling with new bone. Laminated or 'onion-skin' reaction occurs with both malignant and benign processes and indicates an intermittent or cyclical process. Codman's triangles are formed by elevation and then destruction of the periosteum. They are usually related to malignant tumours but can also be formed by aggressive benign processes.

41) A 21-year-old man presents with right hip pain. He has a history of Ewing's sarcoma of the right hemi-pelvis when aged 11, which was treated with limb-sparing surgery and chemoradiotherapy. Plain radiography shows well-defined regional sclerosis, and isotope bone scan demonstrates a corresponding photopenic area. What is the most likely cause of his pain?

- a. recurrent Ewing's sarcoma
- b. heterotopic ossification
- c. radiation necrosis
- d. osteoarthritis
- e. osteosarcoma

41) c. \*\*\*

Ewing's sarcoma is a relatively common malignant bone marrow tumour related to, and sharing a common chromosomal translocation with, peripheral neuroectodermal tumours. It is a very aggressive tumour that is expressed in the radiological findings of permeative osteolysis,

cortical erosion, periostitis and a soft-tissue mass. It principally affects the lower half of the skeleton, with the most frequent location being metadiaphyseal in the femur, ilium, tibia, humerus, fibula and ribs. Both radio- and chemotherapy are used in treatment. Sclerosis within several months of treatment usually indicates bone healing or disease recurrence/persistence. Radiation-induced osteonecrosis is mainly an effect on the osteoblasts and is dose dependent (deterministic). It may be seen within the mandible within 1 year, but in other sites the latent period is longer and can be a number of years.

53) Of the following subtypes of osteosarcoma, which is associated with the most favourable 5-year survival?

- a. multicentric
- b. periosteal
- c. paraosteal
- d. telangiectatic
- e. soft-tissue

53) c. \*\*

Osteosarcoma is the second most common primary malignancy of bone after multiple myeloma, accounting for 15% of all primary bone tumours. It usually affects those aged 10–30. Ninety-five per cent are of the primary osseous type and, of these, paraosteal osteosarcoma has the most favourable 5-year survival rate of 80%. Other osteosarcomas of the primary osseous type include periosteal (5-year survival rate 50%)



and telangiectatic (less than 20%). Multicentric refers to synchronous osteoblastic osteosarcomas at multiple sites. It occurs exclusively in children aged 5–10, and carries an extremely poor prognosis. The soft-tissue type is rare, representing only 1.2% of all soft-tissue tumours. These lesions are primary soft-tissue tumours with no attachment to bone. Death occurs within 3 years in the majority of cases, tumour size being the major predictor of outcome.

- 78) A 30-year-old man undergoes MRI of the whole of the left lower limb and pelvis for a mid-femoral destructive lytic lesion identified on radiography that is thought to represent a primary bone tumour. MRI shows that the disease is confined to the femur with a 5 cm diaphyseal lesion and a 1 cm proximal metaphyseal skip lesion. No enlarged lymph nodes are identified. CT scans of the chest, abdomen and pelvis show two metastatic nodules in the lower lobe of the left lung. Subsequent biopsy confirms the diagnosis of osteosarcoma. The cancer is correctly staged as which of the following?

- a. T1 N0 M0
- b. T1 N0 M1a
- c. T2 N0 M1b
- d. T3 N0 M1a
- e. T3 N0 M1b

T1 < 8 cm T2 > 8 cm  
 T3 skip lesion of any size  
 N0 no nodes N1 any number of  
 M0 no metastases  
 M1a lung  
 M1b other site

- 78) d. \*\*\*\*

Complete staging of primary bone sarcomas is unusual in that it also incorporates the histological staging once tissue diagnosis via biopsy or surgical resection is available. The local TNM classification is T1 (single lesion less than 8 cm), T2 (single lesion over 8 cm) or T3 (skip lesions of any size). Nodal staging is N0 (no nodes) or N1 (any number of metastatic nodes). Metastatic spread is staged, accordingly, as M0 (no metastases), M1a (metastases to lung) or M1b (any other distant site). Once histology is available, tumours can be staged I–IV.

- 93) An elderly man undergoes  $^{99m}\text{Tc}$ -labelled diphosphonate bone scintigraphy. There is no uptake of tracer in the soft tissues, urinary tract or appendicular skeleton, but the axial skeleton shows diffuse homogeneous tracer uptake. No focal lesions are seen. What is the most likely cause of these appearances?
- a. prostatic metastases
  - b. renal osteodystrophy
  - c. Paget's disease
  - d. mastocytosis
  - e. myelofibrosis

93) a. \*\*

The resulting pattern following diffuse uptake of  $^{99m}\text{Tc}$ -labelled diphosphonates in the axial skeleton, with little or no uptake of tracer in the soft tissues or urinary tract, is frequently referred to as a **superscan**. When there is little uptake in the limbs, the cause is most likely to be diffuse metastases in the axial skeleton, most commonly **prostatic or breast**. Uptake in metabolic bone disease is more uniform in appearance, and extends into the distal appendicular skeleton. Intense calvarial uptake disproportionate to that in the remainder of the skeleton may also be seen. The most important factor is to recognize the scan as abnormal in the absence of focal lesions. The lack of renal uptake (**absent kidney sign**) is a useful discriminator.

94) A 65-year-old man undergoes radiographs of the lumbar spine and pelvis for lower back pain. A destructive lytic lesion is identified in the midline of the inferior sacrum with internal areas of calcification. Subsequent MRI reveals a heterogeneous lesion replacing much of the sacrum, which returns moderate low signal on T1W and high signal on T2W images, with a soft-tissue component extending into the presacral soft tissues. The lesion shows patchy moderate enhancement with intravenous gadolinium. What is the most likely diagnosis?

- a. metastasis
- b. giant cell tumour
- c. aneurysmal bone cyst
- ☒ d. chordoma
- e. plasmacytoma

94) d. \*\*

Chordomas arise from notochordal rests and therefore almost always occur in the midline. They are the most common primary malignant sacral tumour and account for 2–4% of all malignant tumours of bone. They are found at all ages but most commonly occur in the fourth to seventh decades of life. Approximately half develop in the sacrococcygeal region. There is usually a large soft-tissue component and the tumour may extend across the intervertebral disc space or sacroiliac joint. Overall, the most common sacral lesion is metastasis due to the high red marrow content, but other primary malignant lesions include myeloma, Ewing's sarcoma and lymphoma. The most commonly found benign tumours are giant cell tumours and aneurysmal bone cysts. Despite being relatively common in the rest of the spine, haemangiomas and osteoid osteomas are rare.



100) Plain radiographs of the femur performed for pain reveal a centrally located lucent lesion in the medulla with a partially calcified matrix. Which of the following features favours a diagnosis of chondrosarcoma over enchondroma?

- a. arc-and-ring matrix calcification
- b. ground-glass matrix
- c. multiple lesions
- d. deep endosteal scalloping
- e. lesion size over 5 cm

100) d. \*\*\*

Distinction of enchondroma and intramedullary chondrosarcoma in the appendicular skeleton proximal to the metacarpals/-tarsals is difficult radiologically. A series of 187 patients showed that chondrosarcoma was associated with endosteal scalloping, with scalloping involving more than two-thirds of the extent of the lesion being strongly suggestive of malignancy. Other powerful discriminating factors identified as favouring chondrosarcoma were cortical destruction, soft-tissue mass, periosteal

reaction, radionuclide uptake at scintigraphy and pain associated with the lesion. Chondrosarcoma also tended to be larger with a mean size of 10 cm compared with 6.7 cm for enchondroma. A ground-glass matrix with arcuate calcification is characteristic of both types of cartilaginous lesion. Multiple lesions may be seen in both malignancy and enchondromatosis (Ollier's disease).

11. A 22 year old man presents to his GP with pain in his right knee which is gradually worsening in severity and is relatively resistant to analgesia. MRI of the knee demonstrates an area of geographic bone destruction in the distal femur with a wide zone of transition. There is marked aneurysmal dilatation of the bone and a fluid-fluid level is present within the lesion. The most likely diagnosis is:

- a. Plasmacytoma
- b. Simple bone cyst
- c. Giant cell tumour
- d. Telangiectatic osteosarcoma
- e. Parosteal osteosarcoma

11. **d. Telangiectatic osteosarcoma**

With the MRI finding described, the most likely explanation is that the lesion is a telangiectatic osteosarcoma. This is a rare type of osteosarcoma with a mean age at presentation of 20 years. The most common site is around the knee (62%). Fluid-fluid levels are also seen in giant cell tumours and aneurysmal bone cysts.

22. A 74 year old woman with back pain presents to her GP. Initial plain radiographs of her spine show multiple sclerotic metastatic lesions. The most likely primary tumour would be:

- a. Renal cell carcinoma
- b. Melanoma
- c. Bronchial carcinoid
- d. Bladder
- e. Colorectal carcinoma

22. **c. Bronchial carcinoid**

The most likely from the above list is a bronchial carcinoid. In men the most likely cause would be prostate. All the other conditions are more likely to produce lytic metastases than sclerotic.

40 A 40-year-old man presented with lethargy and knee pain. A radiograph showed a diaphyseal lesion with bone destruction. What diagnosis would be most likely?

- a Osteoblastoma
- b Non-ossifying fibroma
- c Lymphoma
- d Chondroblastoma
- e Aneurysmal bone cyst

40- Answer C: Lymphoma

Lymphoma of bone is more commonly non-Hodgkin's lymphoma and is predominantly diaphyseal. None of the other lesions are classically diaphyseal nor would they explain his constitutional symptoms.

- 42 A 35-year-old lady with a two-month history of pain, localised swelling and reduced range of movement of her right knee was shown to have a lytic subarticular lesion in the epiphysis and metaphysis of her distal femur. No surrounding sclerosis or soft-tissue swelling was seen. A subsequent MRI showed heterogeneous signal on both T1- and T2-weighted images. No fluid/fluid levels were visible. What is the most likely diagnosis?
- a Metastatic breast deposit
  - b Enchondroma
  - c Aneurysmal bone cyst
  - d Desmoplastic fibroma
  - e Giant cell tumour

42 Answer E: Giant cell tumour

Giant cell tumours are seen in skeletally mature patients. They are epiphyseal/metaphyseal, most common in the distal femur and do not cause surrounding sclerosis. Desmoplastic fibromas are osteolytic and metaphyseal but usually have well-defined sclerotic margins. Aneurysmal bone cysts do occur in this age but are metaphyseal and one would expect to see fluid levels within the cystic spaces on MRI. Metastatic breast deposits are generally diaphyseal and rare in this age group. Enchondromas are diaphyseal and have matrix mineralisation.

- 43 A 38-year-old female presented with a large, destructive giant cell tumour in her distal femur. What is the most appropriate management?
- a Wide resection and reconstruction with allograft
  - b Curettage and bone graft
  - c Embolisation
  - d Radiotherapy
  - e Conservative management
  - f Chemotherapy

43 Answer A: Wide resection and reconstruction with allograft

Allograft resection is the treatment of choice for a large giant cell tumour causing destruction. A wide resection is preferred as a marginal resection is associated with a high recurrence rate. Chemotherapy has no role in the management of this tumour.

- 44 A 22-year-old man presented with pain and swelling of his right knee having knocked it while playing football. The X-ray revealed a destructive lesion in the proximal tibia with a mixed sclerotic/lytic appearance. A 'hair on end' type periosteal reaction was also visible. An MRI showed intermediate signal with foci of high signal intensity on T1- and heterogeneous high-signal T2-weighted images. What is the most likely diagnosis?
- a Osteoid osteoma
  - b Osteochondroma
  - c Osteosarcoma
  - d Chondromyxoid fibroma
  - e Chondrosarcoma

44 Answer C: Osteosarcoma

Osteosarcoma is a high-grade intramedullary tumour. It has high signal on T2W MRI due to replacement of the normal bone marrow and foci of high signal on T1W MRI because of central haemorrhage. An osteoid osteoma would not have significant periosteal reaction. Osteochondroma is painless with no periosteal reaction. Chondromyxoid fibroma occurs in the third or fourth decade. It is a lucent lesion with a sclerotic rim. Chondrosarcoma is unlikely in this age group, usually present over 40 years of age.

- 46 A 76-year-old man presented with pain in his left femur. There was a long history of Paget's disease and bony tenderness about his knee on the medial femoral condyle. He denied any history of trauma and a radiograph showed an area with sunburst periosteal reaction within the Pagetoid bone. What is the most likely diagnosis?
- a Osteosarcoma
  - b Osteochondroma
  - c Chondrosarcoma
  - d Fibrous dysplasia
  - e Osteomalacia

46 \* Answer A: Osteosarcoma

Osteosarcomas are the most common and aggressive primary bone tumours. Despite the potential of arising in any bone, the majority arise in the metaphyseal growth plates of long bones. Other sites are the pelvis and jaw. The peak incidence is in the second and third decades but there is a second peak in the seventh and eighth decades, chiefly as a result of malignant transformation in Paget's disease.

- 52 A six-year-old child presented unwell with a history of 12 weeks of pain and swelling over the left knee. On examination they were pyrexial and noted to have a knee effusion. Blood tests showed a raised erythrocyte sedimentation rate (ESR) and a radiograph showed an aggressive destructive lesion with a permeative pattern of bone destruction in the distal femur and a lamellated ('onion skin') periosteal reaction. What is the most likely diagnosis?
- a Ewing sarcoma
  - b Brodie's abscess
  - c Trauma
  - d Secondary neuroblastoma
  - e Eosinophilic granuloma

52 Answer A: Ewing sarcoma

With Ewing sarcoma 'onion skinning' reflects the periodic activity of the sarcoma interspersed with quiescent periods. Brodie's abscess is high on the differential given the systemic upset, but usually has a lytic area with surrounding sclerosis.

Trauma is not likely due to the insidious onset. Neuroblastoma typically occurs under the age of five.

- 53 A 15-year-old boy was recently diagnosed with a Ewing sarcoma of his vertebral column. Which segment is most likely to be affected?
- a Cervical spine
  - b Thoracic spine
  - c Lumbar spine
  - d Sacrum
  - e Coccyx

53 Answer D: Sacrum

When Ewing's affects the spine the sacrum is most commonly affected, followed by the lumbar, thoracic and cervical regions in that order.

- 55 A 32-year-old man presents with pain and swelling in his right shoulder of four years' duration that has gradually been getting worse recently. He works as a mechanic and has been having increasing difficulty using his right arm for the last few months but is otherwise well. On examination he has an obviously swollen right shoulder. A firm mass is palpable over the lateral aspect of his proximal humerus, extending distally to his elbow. There are also multiple palpable axillary lymph nodes. A radiograph of his shoulder shows a mottled, permeative lucency in the head of the humerus. What is the most likely diagnosis?
- a Eosinophilic granuloma
  - b Ewing sarcoma
  - c Metastatic deposit
  - d Non-Hodgkin's lymphoma
  - e Osteomyelitis

55 Answer D: Non-Hodgkin's lymphoma

It is very rare for Hodgkin's disease to present in bone and most intraosseous lymphomas are of the non-Hodgkin's type:

- 56 A nine-year-old girl presented with pain and swelling of her left lower leg over the anteromedial aspect of her tibia. A radiograph showed an aggressive lesion with mixed lytic/sclerotic appearances in the proximal tibial metaphysis. A biopsy was taken which showed odd-looking pleomorphic cells and stained positive for osteoid. What is the most likely diagnosis?
- a Granulocytic sarcoma
  - b Ewing sarcoma
  - c Osteosarcoma
  - d Aneurysmal bone cyst
  - e Osteoid osteoma



**56 Answer C: Osteosarcoma**

Osteosarcoma is an aggressive lesion that can be mixed lytic/sclerotic in appearance and is common at this age and site. Granulocytic sarcoma occurs in patients with leukaemia or other myeloproliferative disorder but is rarely sclerotic. Ewing sarcoma has a moth-eaten appearance and is usually lytic. Aneurysmal bone cysts are not aggressive. Osteoid osteoma has a nidus and no bony destruction.

- 59** A 25-year-old patient presented with back pain and was found to have a single abnormally dense vertebra, which remained of normal size and shape. The endplates were of normal appearance. What diagnosis is the most likely?
- a Haemangioma
  - b Ankylosing spondylitis
  - c Metastatic deposit from thyroid carcinoma
  - d Osteomyelitis
  - e Sclerotic osteosarcoma

**59 Answer E: Sclerotic osteosarcoma**

Ivory vertebrae occur due to an increase in opacity of a vertebral body while retaining its size and contours. The differential also includes osteoblastic metastases with sclerotic response, Paget's disease, osteopetrosis, fluorosis, lymphoma and myelosclerosis. Osteomyelitis does produce sclerosis in vertebrae, but it rarely affects a single vertebra and one would expect erosive change at the endplates.

- 65** What is the sex distribution of patients who develop Ewing sarcoma?
- a 4 Male: 1 Female
  - b 2 Male: 1 Female
  - c 1 Male: 1 Female
  - d 1 Male: 2 Female
  - e 1 Male: 4 Female

65 Answer D: 1 Male: 2 Female

Most bone tumours either have an even sex distribution or are more common in men except Ewing's, aneurismal bone cysts, haemangiomas and giant cell tumours.

- 32 A 54-year old lady presented with severe progressive pain in her lumbar spine. As she had a past history of breast cancer (treated with a wide local excision and radiotherapy) a Technetium-99 bone scan was requested. This showed diffuse uptake throughout the lumbar vertebrae and ribs. Which of the following anatomical sites is most suggestive of metastatic bony disease?
- a Vertebral body
  - b Lamina
  - c Pedicle
  - d Sternum
  - e Superior articular facet

32. Answer A: Vertebral body

The most common site for metastatic involvement is the anterior aspect of the vertebral body. Increased uptake in the posterior elements and especially facet joints is more suggestive of degenerative change.

- 37 A 14-year-old boy with a three-week history of persistent pain in his right leg presented to hospital. He was noted to have a temperature of 37.8°C and a radiograph of his leg showed a diaphyseal mass in the right femur with overlying cortical erosion and soft-tissue swelling. A bone biopsy was undertaken showing numerous small round blue cells. Which of the following tumours is he most likely to have?
- a Neuroblastoma
  - b Medulloblastoma metastasis
  - c Osteoblastoma
  - d Ewing's sarcoma
  - e Chondroblastoma

**37** Answer D: Ewing sarcoma

Ewing sarcoma is commonest in this age group and in a diaphyseal location. Neuroblastoma microscopically does contain small blue cells but typically locates in the adrenal gland of children. Medulloblastoma is composed of small blue cells but typically is found in posterior fossa of children. Osteoblastoma is essentially a large osteoid osteoma. Chondroblastomas are epiphyseal tumours.

**39** An elderly gentleman presented with a two-month history of back pain. There was no history of significant osteoarthritis and no history of trauma. Plain radiographs revealed multiple sclerotic lesions scattered throughout the spine, which were confirmed as sites of increased uptake on a Tc-99 radionuclide bone scan. What primary tumour is most likely?

- a Breast
- b Thyroid
- c Kidney
- d Prostate
- e Lung

**39** Answer D: Prostate

Prostate cancer is well-known for causing osteoblastic metastases. Breast and lung cancer produce mixed lytic and sclerotic metastases. Kidney and thyroid cancers are usually purely lytic.

**44** A 22-year-old man was found to have an osteosarcoma of his proximal tibia. How should this patient be managed?

- a Curettage and bone grafting
- b Above knee amputation
- c Wide resection only
- d Wide resection and chemotherapy
- e Wide resection and radiotherapy

**44** Answer D: Wide resection and chemotherapy

Wide surgical margins and limb-sparing resection combined with chemotherapy is the most successful regime. Pre- and post-operative chemotherapy significantly improves outcome.

- 45** A 55-year-old man presented with leg pain and a suspicious lesion was seen on a radiograph. Bone biopsy showed an osteogenic sarcoma and referral to the regional oncology centre was undertaken. What is the most important initial staging investigation?
- a Chest X-ray
  - b MRI brain
  - c Lymphoscintigram
  - d US liver
  - e IVU renal tract

**45** Answer A: Chest X-ray

Lung metastases are the most common metastases from sarcomas, including osteogenic sarcomas. He may also need a CT but of the available options a CXR is the best initial test.

- 46** A 68-year-old man presents with insidious onset right-sided shoulder pain. He gives no history of trauma but has recently lost some weight. On examination, he has a markedly reduced range of movement of the shoulder with a palpable mass. An AP radiograph shows 'popcorn' calcification in the head of the humerus. What is the most likely diagnosis?
- a Chondroblastoma
  - b Osteosarcoma
  - c Chondrosarcoma
  - d Multiple myeloma
  - e Desmoplastic fibroma

**46** Answer C: Chondrosarcoma

Chondrosarcoma generally occurs in adults over the age of 60 and the proximal humerus is a common location. 'Popcorn' calcification is a typical radiological sign. Chondroblastoma occurs in a much younger patient population (10–30 years) and typically has a sclerotic border.

- 51 An eight-year-old boy presented with an insidious onset of right-sided shoulder pain. A radiograph showed an aggressive-looking lytic lesion in the metadiaphysis of the proximal humerus. An MRI was subsequently performed, which showed a circumferential extraosseous extension of the tumour with intermediate signal (similar to fat) on T2-weighted images with surrounding oedema. What is the most likely diagnosis?
- a Osteomyelitis
  - b Lymphoma
  - c Ewing sarcoma
  - d Acute bone infarction
  - e Chondroblastoma

51 Answer C: Ewing sarcoma

The intermediate signal on T2 is due to the presence of hypercellular tumour combined, which suggests extensive soft-tissue disease, a characteristic feature of Ewing sarcoma. Osteomyelitis can mimic changes of an aggressive bone tumour but is not the most likely diagnosis here. Lymphoma tends to affect older children. Chondroblastoma does occur in this age group but arises in the epiphysis and has a sclerotic rim.

- 55 A 19-year-old man presented with a history of knee pain and swelling aggravated by movement. His blood tests showed a mildly raised white cell count and raised alkaline phosphatase (ALP). A radiograph showed a Codman's triangle at the margin of a soft-tissue mass. What is the most likely diagnosis?
- a Brodie's abscess
  - b Osteosarcoma
  - c Ewing sarcoma
  - d Haematoma
  - e Histiocytosis X

55 Answer B: Osteosarcoma

The most common site for osteosarcoma is the distal femur. Pain is worse with activity and with a high ALP the patient is more likely to have lung metastases.

- 57 An 86-year-old man was admitted to hospital being unable to weight bear and in poor general health. A pelvic radiograph showed multiple well-circumscribed radiolucent lesions in the iliac wings of the pelvis and a well-defined punched out lesion in the left femoral shaft with disuse osteopenia. What is the most likely diagnosis?
- a Metastatic prostatic deposits
  - b Multiple myeloma
  - c Fibrous dysplasia
  - d Chondrosarcoma
  - e Simple bone cysts

57 Answer B: Multiple myeloma

Multiple myeloma classically presents with well-demarcated, radiolucent lesions without a sclerotic border which may be symmetrical and may be associated with osteopenia. It would be unusual for prostatic metastases to be so well-defined, lytic and widespread.

- 59 A 34-year-old man with arm pain had a radiograph which showed a permeative lesion in his humerus, which was expansile and associated with a soft-tissue mass and moderate amount of lamellated periosteal reaction. What is the most likely cause?
- a Simple bone cyst
  - b Lymphoma of bone
  - c Chondroblastoma
  - d Multiple myeloma
  - e Non-ossifying fibroma

59 Answer B: Lymphoma of bone

Of the options listed lymphoma is most likely to have this appearance; in particular it is relatively slow growing. Multiple myeloma is lucent but has no expansion. A sarcoma would also be possible but is not listed.



- 63 At what age is an eosinophilic granuloma most likely to present?
- a 0–5 years
  - b 5–10 years
  - c 10–20 years
  - d 30–50 years
  - e Over 50 years

63 Answer B: 5–10 years

- 6 A 70-year-old man is known to have histologically confirmed prostate cancer following an ultrasound-guided biopsy a month ago. His PSA has risen to 42 ng/mL and he presents to clinic with increasing lower back pain but no neurology. Which of the following is the single best form of appropriate imaging?
- a Plain film skeletal survey
  - b Radionuclide whole body bone scan
  - c CT whole spine
  - d Contrast enhanced MR of the lumbar spine and pelvis
  - e Three-phase radionuclide bone scan of the lumbar spine and pelvis

Full marks

- 6 Answer B: Radionuclide whole body bone scan

Skeletal survey is more appropriate for multiple myeloma screening. Some literature states PSA < 20 does not warrant a bone scan although centres vary in their practice. CT of the whole spine is unnecessary, although a targeted study can be useful if there is doubt. Similarly MR can be performed but this should be targeted at areas flagged up by a bone scan. Three-phase bone scans are used for targeted regions to assess for loosening and infection.

- 36 An 83-year-old man was admitted to hospital with a chest infection. Blood tests showed a markedly elevated serum alkaline phosphatase, low albumin, elevated calcium and reduced phosphate. A radiograph of his lumbar spine showed multiple poorly defined sclerotic lesions. What is the most likely underlying diagnosis?
- a Fibrous dysplasia
  - b Ewing sarcoma
  - c Osteomalacia
  - d Osteochondromatosis
  - e Prostate carcinoma

36 Answer E: Prostate carcinoma

Elevated alkaline phosphatase in elderly men must raise the suspicion of bony metastases from prostate carcinoma, which is the commonest cause of sclerotic metastases.

- 37 A 43-year-old gentleman presented with hyperglycaemia and left-sided chest pain over a period of four months. A radiograph of his chest demonstrated a mass centred on a rib destroying the overlying cortex and associated with a soft-tissue mass. The hyperglycaemia was investigated and felt to be a paraneoplastic phenomenon. What is the most likely diagnosis?
- a Adamantinoma
  - b Chondrosarcoma
  - c Osteosarcoma
  - d Myeloma
  - e Ewing sarcoma

37 Answer B: Chondrosarcoma

Both chondrosarcoma and osteosarcoma commonly present with paraneoplastic hyperglycaemia (85% of cases with central chondrosarcoma, 25% of osteosarcoma) but the patient's age and the site are more typical for a chondrosarcoma.

- 43 A 73-year-old male with a history of Paget's disease presented with insidious onset low back pain and was assessed with radiographs and MRI, CT and bone scans. Radiographs showed a mixed lytic/sclerotic appearance in the sacrum and an MRI showed infiltration of all five sacral segments with additional anterior soft-tissue extension. There was evidence of osteoid mineralisation within this mass on CT. A bone scan showed these were the only hotspots. What is the most likely diagnosis?
- a Sclerotic metastasis
  - b Lymphoma
  - c Ewing sarcoma
  - d Osteoblastoma
  - e Osteosarcoma

43 Answer E: Osteosarcoma

Osteosarcoma may rarely arise in Paget's disease through malignant degeneration. Sclerotic metastases are probably more common even in someone known to have Paget's but are usually multifocal and would rarely involve only one part of one bone.

- 44 A 22-year-old male with an osteosarcoma of his tibia underwent a staging CT which demonstrated a small nodule in his left lower lobe that was thought to represent a metastasis. What is the prognosis for patients with this clinical picture?

(Options given as percentage surviving five years from diagnosis)

- a 60–80%
- b 40–50%
- c 30–40%
- d 20–30%
- e 10–20%

44 Answer E: 10–20%

Osteosarcoma has a very poor prognosis once metastases are present.

- 51 Based on age alone, what is the most likely primary bone tumour in a 45-year-old male?
- a Osteosarcoma
  - b Chondrosarcoma
  - c Giant cell tumour
  - d Aneurysmal bone cyst
  - e Osteoid osteoma

51 Answer B: Chondrosarcoma

Chondrosarcoma tends to occur in those over 40 and the median age at presentation is 45 years. Giant cell tumour has a peak incidence in the third and fourth decades, and has a female preponderance. Osteosarcoma is most often seen in the first to third decades of life, although there is a second peak after the age of 60 due to Paget's disease. Aneurysmal bone cyst is most commonly present in the second and third decades and osteoid osteoma in the first three decades.

- 52 A 15-year-old boy was recently diagnosed with Ewing sarcoma. What is the most likely bone to be affected?
- a Femur
  - b Humerus
  - c Sacrum
  - d Scapula
  - e Tibia

52 Answer A: Femur

The most common location is the femur followed by the ilium, tibia, humerus, fibula sacrum and ribs in that order.

- 53 A 14-year-old girl was recently diagnosed with a Ewing sarcoma of her left femur. Which part of the bone is most likely to be affected?
- a Epiphyseal
  - b Epiphyseal and metaphyseal
  - c Metaphyseal
  - d Metaphyseal and diaphyseal
  - e Diaphyseal

53 Answer D: Metaphyseal and diaphyseal

Approximately two-thirds of Ewing sarcomas affect long bones and half of these are centred in the metadiaphysis.

54 A 16-year-old boy noticed pain in his knee during his weekly football practice, which was gradually increasing in severity over months. A radiograph showed an aggressive lesion causing a moth-eaten appearance of bone destruction and an associated soft-tissue mass centred on the distal femur. What is the most likely diagnosis?

- a Chondrosarcoma
- b Metastasis
- c Osteochondroma
- d Osteogenic sarcoma
- e Synovial sarcoma

54 Answer D: Osteogenic sarcoma

Osteogenic sarcoma is the most common primary malignant bone tumour. It classically affects adolescents with a second peak in incidence after the age of 60 due to Paget's disease. The typical presentation is with pain of several weeks' duration, commonly with activity. The most common bones involved are the femur and tibia with the majority of lesions occurring around the knee. An important differential is osteomyelitis.

59 A 55-year-old man had a history of renal cell carcinoma treated with a radical nephrectomy 10 months previously (T4N1M0). He was thought to be in remission but developed bony pain in his lumbar spine. Lumbar radiographs revealed an abnormality that showed increased uptake on a subsequent Tc-99MDP bone scan. What is the most likely appearance of this lesion on the plain film?

- a Expansile, lytic lesion
- b Non-expansile, lytic lesion
- c Expansile, sclerotic lesion
- d Non-expansile sclerotic lesion
- e Non-expansile, mixed sclerotic/lytic lesion

59 Answer A: Expansile, lytic lesion

Thyroid and renal cell carcinoma metastases are nearly always osteolytic. Other causes of lytic metastases include melanoma, lung and breast carcinomas. The most common causes of sclerotic metastases are prostatic, breast, colonic and bladder carcinomas in addition to melanoma and soft-tissue sarcomas.

**14. A 60-year-old man presents to the A&E department with acute onset lower back pain following a relatively minor fall. A plain film reveals a collapse of the L4 vertebral body against a background of osteopenia. He has a history of renal cell carcinoma and the clinical team request an MRI to 'rule out metastatic disease'. Which of the following features would most suggest a malignant rather than a benign cause for a vertebral compression fracture?**

- A. Isointense signal to adjacent vertebral bodies on T2WI.
- B. A band-like area of low signal adjacent to the fractured end-plate on T1WI.
- C. High signal intensity adjacent to the vertebral endplate on STIR imaging.
- D. Retropulsion of a posterior fragment into the spinal canal.
- E. A convex bulge involving the whole of the posterior cortex of the vertebral body.

**14. E.** A convex bulge involving the whole of the posterior cortex of the vertebral body.

The others are more in keeping with benign compression fractures. Retropulsion of a posterior fragment into the spinal canal is a highly specific (100%) finding of benign compression fracture, but has a sensitivity of only 16%. Other features in keeping with malignant compression fractures are complete replacement of normal marrow with low signal on T1WI, involvement of the pedicles, and the presence of an epidural and/or paraspinal soft-tissue mass. The presence of an epidural mass is said to have 80% sensitivity and 100% specificity for malignant fractures. Convex bulging of the posterior cortex of the vertebra and involvement of the pedicle have respective sensitivities and specificities of 70% and 94%, and 80% and 94%. Beware that compression fractures due to multiple myeloma only rarely show MRI features of malignant fracture and this diagnosis should be included in the differential of a non-traumatic, benign-appearing vertebral compression fracture.



**24. A 75-year-old man presents with bone pain. Investigations reveal anaemia, renal impairment, hypercalcaemia, proteinuria, and a monoclonal gammopathy. He undergoes radiological investigation. Which of the following is most correct in relation to the radiological features of the disease process?**

- A. 25% bone destruction must occur on plain film before a lesion will be apparent on plain film.
- B. 75% of patients will have positive radiographic findings on plain film.
- C. MRI typically reveals general hypointensity of bone marrow on T2WI sequences.
- D. MRI typically reveals general hyperintensity of bone marrow on T1WI sequences.
- E. The use of PET is inappropriate for imaging recurrent disease.

**24. B.** 75% of patients will have positive radiographic findings on plain film.

The clinical vignette alludes to a diagnosis of multiple myeloma (MM) and 50% bone destruction must occur before a myelomatous lesion will be visible on plain film. Four distinct forms of bony involvement have been described in MM: (1) plasmacytoma, a solitary lytic lesion that predominately affects the spine, pelvis, skull, ribs, sternum, and proximal appendages, (2) diffuse skeletal involvement (myelomatosis), which classically manifests as osteolytic lesions with discrete margins and uniform size, (3) diffuse skeletal osteopenia, without well-defined lytic lesions, which predominately involves the spine (multiple compression fractures may be seen with this pattern), (4) sclerosing myeloma, which results in sclerotic bony lesions, and is associated with POEMS syndrome (polyneuropathy, organomegaly, endocrinopathy, monoclonal gammopathy and skin changes).

As well as typically producing general hyperintensity on T2WI and hypointensity on T1WI in diffuse myelomatous involvement, plasmacytomas may produce focal areas of hypointensity on T1WI/hyperintensity on T2WI. STIR imaging allows better assessment of marrow involvement; fat-suppressed post contrast studies can demonstrate enhancement in focal or diffuse disease. These findings are not specific for MM and may be seen in spinal metastases. However, MM is suspected whenever MR images depict an expansile focal mass, multiple focal masses in the axial skeleton, diffuse marrow involvement, particularly at known sites of normal hematopoiesis, or multiple compression fractures in a patient with no known primary malignancy.  $^{99m}\text{Tc}$ -based bone scanning under-appreciates the extent of disease. FDG-PET has been used to study relapsing patients in whom recurrent disease is not easily detectable with routine imaging. PET, in this instance, has been found to aid in the detection of unsuspected sites of medullary and extramedullary disease.

**29. A 25-year-old man presents with a painful knee. A plain film reveals a lucent area with a wide zone of transition in the distal femoral metaphysis. MRI reveals fluid–fluid levels. What is the most likely diagnosis?**

- A. Aneurysmal bone cyst.
- B. GCT.
- C. Osteosarcoma.
- D. Chondroblastoma.
- E. Osteoblastoma.

**29. C. Osteosarcoma.**

The telangiectatic variety of osteosarcoma does show fluid–fluid levels, as does malignant fibrous histiocytoma or any necrotic bone tumour. Telangiectatic osteosarcoma is highly vascular and contains necrotic tissue and blood, with tumour located only along the periphery and septa. MRI will thus reveal enhancing nodularity in the latter locations; this finding will be absent in the case of ABC or GCT. In addition to those mentioned in the stem, the plain film findings include bone expansion and cortical breakthrough.

Unlike the other lesions, osteoblastoma does not demonstrate fluid–fluid levels on MRI; it is more common in the posterior elements of the spine than in the long bones. ABC, GCT, and chondroblastoma have a narrower zone of transition on plain film than telangiectatic osteosarcoma. GCT is subarticular. Chondroblastoma is epiphyseal.

Other benign causes of fluid–fluid levels include simple bone cysts and fibrous dysplasia.

**51. A 45-year-old female undergoes aggressive chemotherapy for bone metastases followed by bone marrow transplantation. Which of the following findings on MRI indicates recurrent metastatic disease instead of rebound hematopoietic marrow?**

- A. Intermediate signal on T1WI.
- B. High signal on T2WI.
- C. Loss of signal on out-of-phase GE images.
- D. High signal on STIR images.
- E. Increased conspicuity on prolonged time-to-echo (TE) images.



**51. E.** Increased conspicuity on prolonged TE images.

Distinguishing recurrent metastases from rebound hematopoietic marrow is difficult on standard T1WI and T2WI sequences because both have intermediate signal intensity on T1WI and high signal intensity on T2WI. They may also occur in same anatomic regions.

Out-of-phase GE imaging is useful in differentiating the two. Most neoplastic processes replace the marrow elements such as fat, osseous trabeculae, and hematopoietic elements, but hyperplastic red marrow does not. Out-of-phase imaging allows detection of intralesional fat by demonstrating a drop in signal intensity compared to in-phase images.

Lengthening of echo results in loss of signal of rebound red marrow due to T2\* dephasing, while the water-laden metastatic foci become more conspicuous.

**57. A** 34-year-old man has a 3-month history of right knee pain. There is a remote history of previous right leg trauma. He has an x-ray of the right knee performed, which demonstrates a densely ossified mass immediately adjacent to the posterior cortex of the distal femur. You determine that the differential diagnosis is between post-traumatic myositis ossificans or a parosteal osteosarcoma. Which of the following features on plain x-ray is likely to be most helpful in distinguishing between these diagnoses?

- A. Periosteal reaction in the adjacent bone.
- B. Presence of lucent areas in the lesion.
- C. Pattern of ossification in the lesion.
- D. Size of the lesion.
- E. Presence of lucent cleft between the lesion and adjacent bone.

**57. C.** Pattern of ossification in the lesion.

The pattern of ossification is likely to be the most helpful. In post-traumatic myositis ossificans, the ossification occurs classically first at the periphery, whereas in parosteal osteosarcoma, the ossification is diffuse, but predominantly central. Periosteal reaction is typically absent in both these lesions and both lesions may contain lucent areas on plain radiograph.

A lucent cleft between the mass and the bony cortex, representing periosteum, is characteristic in parosteal osteosarcoma, but frequently is not seen as the tumour envelops bone. A thick lucent zone separating myositis ossificans from an adjacent bony cortex is typical, but may not be seen on plain radiograph if the lesion is immediately juxta-cortical.

**58. You are reviewing a plain film of pelvis of a 70-year-old woman with recent hip pain. She has a past medical history of bronchial carcinoid. You notice thick, coarsened trabeculae of the left iliac bone, but in comparison to a previous film there is an area of cortical destruction with 'ring-and-arc' calcification. There is no adjacent periosteal reaction. Which of the following is the most significant pathology present?**

- A. Paget's disease.
- B. Chondrosarcoma.
- C. Osteosarcoma.
- D. Chondroblastoma.
- E. Lung metastasis.

**58. B. Chondrosarcoma.**

The findings describe development of chondrosarcoma in an area of Paget's disease. While osteosarcoma is more common than either malignant fibrous histiocytoma or chondrosarcoma in Paget's disease, the 'ring-and-arc' calcification in the vignette indicates chondroid rather than osteoid calcification. Sarcomatous transformation in Paget's is rare, occurring in approximately 1% of cases, but should be suspected if there is new focal pain or swelling. Such lesions, even osteosarcomas, are usually lucent. Periosteal reaction is often absent due to the rapidity of bone destruction.

Other complications of Paget's disease include those related to osseous weakening (deformity and fracture), arthritis, neurological entrapment, and both benign and malignant GCT.

Chondroblastoma may have internal chondroid calcification (60%) but is a well-defined, benign, lucent lesion with a sclerotic rim occurring in the epiphyses of children and young adults.

Bronchial carcinoid metastases are usually purely osteoblastic (i.e. sclerotic, not lucent).

**73. A radiologist is reporting a  $^{99m}\text{Tc}$  bone scan and describes it as a 'superscan'. He can say this because of reduced uptake in the:**

- A. brain
- B. skeleton
- C. kidneys
- D. bowel
- E. myocardium.

13 (a)

Myositis ossificans is a form of heterotopic bone formation within skeletal muscle, usually resulting from blunt trauma. Although parosteal osteosarcoma can have similar appearances, myositis ossificans typically has denser calcification in the periphery; osteosarcoma shows the reverse phenomenon, with denser calcification centrally. Juxtacortical chondroma typically scallops the underlying cortex. An osteochondroma is continuous with the underlying bone.

- 35 A 50 year old man presents with knee pain. Plain radiographs show an 8 cm lytic lesion within the distal femoral metaphysis with endosteal scalloping and cortical thickening. CT shows matrix mineralisation.

Which of the following features does not favour a diagnosis of chondrosarcoma over enchondroma?

- (a) The patient's age
- (b) The patient's sex
- (c) The lesion size
- (d) The lesion site
- (e) The CT findings

*favour chondrosarcoma*

*enchondroma*  
① younger / old  
② female  
③ < 5cm

35 (e)

Enchondromas present in a slightly younger age group and are more common in females. They typically affect the bones of the hands and feet and are usually less than 5 cm in size. Although both lesions show matrix mineralisation, this feature is slightly commoner in enchondromas. Other features to favour chondrosarcoma over enchondroma include presentation with a mass, cortical destruction and the presence of a soft tissue mass.



- 44 A 38-year-old woman presents with a palpable lump in her thigh. Plain films show a lobulated ossified mass lying posterior to the femur with a connection to the cortex. The centre of the lesion is denser than the periphery. MRI shows a large associated soft tissue component.

What is the likeliest diagnosis?

- (a) Myositis ossificans
- (b) Osteochondroma
- (c) Parosteal osteosarcoma *have the best prognosis of all osteosarcomas*
- (d) Periosteal osteosarcoma
- (e) Extrasosseous osteosarcoma

44 (c)

Parosteal osteosarcomas have the best prognosis of all osteosarcomas. If no stalk can be clearly identified they can be distinguished from myositis ossificans by the relative density of the centre of the ossified part of the lesion.

### 73. C. Kidneys

A superscan refers to a  $^{99m}\text{Tc}$ -labelled technetium IBS where there is diffuse increased osseous uptake with *apparent* reduced renal and soft tissue uptake. The appearance is commonly due to widespread osteoblastic bony metastases (e.g. prostate or breast carcinoma), but is also caused by non-malignant disease (e.g. renal osteodystrophy, hyperparathyroidism, osteomalacia, myelofibrosis, Paget's disease). In metastatic disease there is usually higher uptake in the axial than the appendicular skeleton.

In IBS uptake is normally seen in bone, kidneys, and bladder; soft tissues (low levels), breasts (particularly in young women), and epiphyses (skeletally immature patients). Uptake is seen in the myocardium (high), brain (high), and bowel (moderate) in FDG-PET scanning, not IBS; however myocardial uptake on IBS can be seen in cases of recent myocardial infarction and amyloidosis. Note that poor renal function can often demonstrate reduced or absent renal visualization producing an appearance similar to a superscan (false positive), whereas urinary tract obstruction in prostatic carcinoma can increase renal activity and lead to false negative scans.



- 13 A calcified mass is seen on a plain radiograph of a young man's femur. The mass appears to be centred within the soft tissues of the thigh and the calcification is more prominent on the periphery of the mass. There is a radiolucent zone separating the lesion from the underlying bone, the cortex of which appears unaffected.

Which of the following is the most likely diagnosis?

- (a) Myositis ossificans *→ calcified periphery*
- (b) Parosteal osteosarcoma *→ calcified center*
- (c) Juxtacortical chondroma
- (d) Osteochondroma
- (e) Rhabdomyosarcoma

13 (a)

Myositis ossificans is a form of heterotopic bone formation within skeletal muscle, usually resulting from blunt trauma. Although parosteal osteosarcoma can have similar appearances, myositis ossificans typically has denser calcification in the periphery; osteosarcoma shows the reverse phenomenon, with denser calcification centrally. Juxtacortical chondroma typically scallops the underlying cortex. An osteochondroma is continuous with the underlying bone.

- 1 You review a plain radiograph of the left femur of a 16 year old patient and note a lesion with a wide zone of transition and a marked 'sunburst' periosteal reaction.

Which of the following is the most likely diagnosis?

- (a) Aneurysmal bone cyst
- (b) Ewing's sarcoma
- (c) Osteosarcoma
- (d) Fibrosarcoma
- (e) Osteoid osteoma

**1 (c)**

Of the above list, osteosarcoma is the most likely. The periosteal reaction (and wide zone of transition) indicates an aggressive lesion. Ewing's sarcoma is more common in the 1–10 year old age group, and fibrosarcoma in the 30–60 year old age group.

- 8 A 23 year old woman complains of anterior chest wall pain. CXR shows a large expansile mass arising from the left 3rd rib. CT confirms the mass is solitary and demonstrates whorled areas of 'rings and arcs' calcification with no soft tissue component.**

**Which of the following is the most likely diagnosis?**

- (a) Osteosarcoma
- (b) Osteoblastoma
- (c) Chondrosarcoma
- (d) Askin tumour
- (e) Plasmacytoma

**8 (c)**

Rings and arcs of calcification indicate a chondroid matrix. Chondrosarcoma is the likeliest primary rib tumour in this age group. Other primary malignant tumours include plasmacytoma and lymphoma.

- 16 A middle aged man presents with low back pain and faecal incontinence. MR imaging of the lumbar spine is performed and a diagnosis of chordoma is subsequently made.**

**Regarding the chordomas, which of the following is incorrect?**

- (a) They typically have poor uptake of  $^{99m}\text{Tc}$ -MDP
- (b) They usually cause extensive local bone destruction
- (c) They most frequently arise in the sacrum or coccyx
- (d) They may have a narrow zone of transition
- (e) Metastasis is common

**16 (e)**

Chordomas arise from notochord remains and are therefore limited to the clivus, spine, sacrum and coccyx. Metastasis is uncommon, but when it does occur, lung secondaries are typical. Tumour size (the average size of a sacrococcygeal chordoma is 10 cm), lytic nature and location are important clues to the diagnosis.

- 31 A patient has widespread metastatic disease. The skeletal metastases are sclerotic.**

**Which of the following primary cancers most commonly produce sclerotic metastases?**

- (a) Renal cell carcinoma
- (b) Carcinoid
- (c) Wilm's tumour
- (d) Ovarian carcinoma
- (e) Melanoma

**31 (b)**

Sclerotic metastases are typically the result of: prostate carcinoma, carcinoid, transitional cell carcinoma, breast (mixed), medulloblastoma, colon (occasionally), and lymphoma.

- 37 A 32 year old woman presents after minor trauma with a lump over the midshaft of her left tibia. Plain films show an 8 cm multilocular, slightly expansile, predominantly lytic lesion with a sclerotic margin, and a narrow zone of transition. The lesion is orientated longitudinally along the anterior tibial diaphysis.**

**What is the most likely diagnosis?**

- (a) Adamantinoma
- (b) Eosinophilic granuloma
- (c) Fibrous dysplasia
- (d) Non-ossifying fibroma
- (e) Chondromyxoid fibroma

**37 (a)**

These are locally aggressive lesions which tend to recur and after several recurrences can metastasize to lungs. The main differential diagnosis for this 'soap-bubble' like appearance is fibrous dysplasia, but this usually presents in a slightly younger age group.

- 49 A 35 year old man presents with leg weakness. Plain films and MRI demonstrate a lesion involving the posterior elements of the L4 vertebra only.**

**Given the location, which of the following lesions is least likely?**

- (a) Eosinophilic granuloma
- (b) Aneurysmal bone cyst
- (c) Osteoblastoma
- (d) Renal cell carcinoma metastases
- (e) Osteoid osteoma

**49 (a)**

Although many expansile lesions can extend to involve both vertebral bodies and posterior elements, the commonly described lesions that preferentially affect the posterior elements are ABC, osteoblastoma, and metastases. EG commonly involves the vertebral body and only rarely involves the posterior elements. Other lesions such as haemangiomata, GCT and myeloma typically affect the vertebral bodies.

**55 A 3 year old child of short stature is found to have numerous bony exostoses on plain radiography.**

**Which of the following statements is not true?**

- (a) Hereditary transmission is autosomal dominant
- (b) Malignant transformation to osteosarcoma occurs in 1%
- (c) The distal femur and proximal tibia are most commonly involved bones
- (d) It is more common in males
- (e) There is an association with polydactyly

**55 (b)**

Hereditary multiple exostoses (also known as diaphyseal aclasia) is an autosomal dominant condition characterised by multiple exostoses. Malignant transformation to chondrosarcoma occurs in 1–5%.

- 66** A 20 year old man presents with a swelling in his thigh. He recalls innocuous trauma at this site a few weeks earlier. Plain films suggest a soft tissue mass with peripheral calcification at the level of the mid femur with a radiolucent zone separating the lesion from cortex. MRI shows a heterogeneous, well defined soft tissue mass, isointense to muscle on T1W and hyperintense on T2W, with curvilinear peripheral areas of low signal intensity.

**Which of the following is the likeliest diagnosis?**

- (a) Myositis ossificans
- (b) Parosteal sarcoma
- (c) Tumoural calcinosis
- (d) Rhabdomyosarcoma
- (e) Chondrosarcoma

**66 (a)**

These are the typical findings of myositis ossificans. Although in the acute stages, it can be confused with other entities, as it matures and calcifies, it can be discriminated from osteosarcomas by the pattern of peripheral calcification and from parosteal sarcomas by the lack of a connecting stalk to the cortex.

- 75** A 13 year old boy presents with a long history of a dull ache in his hip. Plain radiographs show a 4cm eccentric lytic lesion of the proximal femoral epiphysis extending to involve the proximal metaphysis. It has a lobulated, well-defined sclerotic margin and areas of calcification within it. There is significant surrounding periosteal reaction.

**Which of the following is the likeliest diagnosis?**

- (a) Enchondroma
- (b) Chondromyxoid fibroma
- (c) Chondrosarcoma
- (d) Chondroblastoma
- (e) Giant cell tumour



**75 (d)**

The main differential diagnosis for epiphyseal lesions would be GCT. However, these typically arise in a slightly older age group and only cross the physis once it has fused. Chondrosarcomas occur in an older age group (median age 45 years) and chondromyxoid fibromas are rare (usually but not exclusively metaphyseal) cartilaginous tumours arising from the cortex.

9) A 30-year-old man undergoes shoulder MRI for chronic anterior pain. There is no history of trauma. Sagittal images reveal an absent anterior labrum with a thickened middle glenohumeral ligament. What is the most likely diagnosis?

- a. anterior labral tear
- b. Bankart's lesion
- c. superior labrum anterior-to-posterior (SLAP) lesion
- d. glenohumeral tendonitis
- e. normal variant *called Buford complex*

9) e. \*\*\*

The findings describe the Buford complex, a normal variant present in 1.5% of the population. It consists of an absent anterior labrum with a thickened cord-like middle glenohumeral ligament. It can be misdiagnosed as a torn or avulsed anterior labrum, resulting in unnecessary shoulder arthroscopy.

14) In the spectrum of perilunate ligamentous injuries and instability, volar tilt of the lunate, seen as a triangular or 'pie-shaped' lunate on the AP projection of the wrist, is most commonly a feature of which of the following?

- a. scapholunate dissociation
- b. perilunate dislocation
- c. lunate dislocation
- d. volar intercalated segmental instability
- e. dorsal intercalated segmental instability

14) c. \*\*\*

The lesser arc refers to the arc of ligamentous attachments around the lunate. These ligaments become disrupted in a stepwise four-stage fashion. Stage I injury is to the scapholunate ligament, leading to dissociation with rotary subluxation of the scaphoid. Stage II is

radiographically characterized by perilunate dislocation, caused by additional injury to the capitolunate joint. The carpus migrates dorsally and the lunate maintains a normal relationship with the radius. Stage III involves the triquetrolunate ligaments, and stage IV is complete disruption of the perilunate ligaments, allowing dislocation and rotation of the lunate. It is this rotation that creates the triangular outline on AP radiographs. Segmental instabilities relate to the spectrum of dynamic scaphoid instability.

- 61) A young man is admitted in cardiac arrest following electrocution. Following successful resuscitation in accident and emergency, he complains of an acutely painful right shoulder with severely decreased range of movement. What is the most likely plain film finding?
- a. anterior shoulder dislocation
  - b. posterior shoulder dislocation
  - c. acromioclavicular dislocation
  - d. fractured surgical neck of humerus
  - e. subacromial impingement

- 61) b. \*\*\*
- Posterior shoulder dislocation is much rarer than anterior dislocation, accounting for only 5% of dislocations. It can be caused by direct or indirect force and is most commonly seen following seizure or electrocution. The internal rotators of the shoulder are stronger than the external rotators, resulting in internal rotation of the arm if all the shoulder muscles contract simultaneously. This internal rotation predisposes to posterior dislocation in the same way that external rotation does for anterior dislocation. Radiographic findings may be subtle on the AP projection, and include superior position of the humeral head relative to the glenoid, external rotation (the humeral head appears symmetrical like a light bulb), a sharp angle to the scapulohumeral arc and a compression fracture of the anterior humeral head (a reverse Hill-Sachs lesion).

55) A young adult male sustains an anterior shoulder dislocation while playing rugby. There is no associated fracture. Following apparently uncomplicated reduction in accident and emergency, he is unable to abduct the arm and complains of numbness over the upper lateral arm. What is the most likely cause?

- a. supraspinatus tendon tear
- b. axillary nerve palsy
- c. musculocutaneous nerve palsy
- d. shoulder impingement
- e. deltoid muscle tear

55) b. \*\*\*

The axillary nerve is a large terminal branch of the posterior cord of the brachial plexus that passes into the posterior aspect of the upper arm via the quadrilateral space, where it winds around the surgical neck of the humerus to supply the deltoid and teres minor muscles. It has a cutaneous distribution called the 'regimental badge area' over the lateral aspect of the deltoid (where a soldier may wear his regimental badge). Due to its intimate relationship with the humerus and its passage through the relatively small quadrilateral space, the axillary nerve is by far the most commonly injured nerve with shoulder dislocation or fractures. As loss of abduction may be caused by pain rather than deltoid paralysis, it is good practice to assess the sensation in the cutaneous distribution of the axillary nerve before and after any attempted shoulder reduction.



62) A middle-aged woman falls on an outstretched hand, which becomes immediately painful and swollen. A lateral radiograph shows a small fracture fragment dorsal to the carpus, and the AP radiograph appears normal. Which carpal bone is most likely to be fractured?

- a. scaphoid
- b. lunate
- c. triquetrum
- d. capitate
- e. hamate

62) c. \*\*

- Carpal fractures in general are much less common than fractures to the distal radius. The two bones most commonly injured are the scaphoid (75%) followed by the triquetrum (14%), and these provide a

greater diagnostic challenge radiographically than distal radial fractures. Triquetrum fractures generally occur on the dorsal surface due to avulsion of the dorsal radiocarpal ligament, or shearing forces from impaction with the ulnar styloid or hamate in hyperextension. Less commonly, the body of the bone can fracture in a transverse pattern. A posterior chip fragment can often be seen with dorsal surface fractures, but is only visualized on the lateral view. Such an injury may be a primary triquetrum injury (such as avulsion) or related to a perilunate fracture-dislocation.

74) A middle-aged man has a history of an undiagnosed wrist injury interfering with his playing golf. He presents with clinically apparent ulnar nerve compression at the wrist. Which of the following causes is most likely to be identified following investigation with CT and MRI?

- a. non-union of hook of hamate fracture
- b. non-union of scaphoid wrist fracture
- c. scapholunate dissociation
- d. pisiform osteoarthritis
- e. triangular fibrocartilage complex tear

74) a. \*\*\*\*\*

Fractures of the hook of the hamate are the most frequent type of hamate fracture, and most often occur from the repetitive stress of swinging a bat, club or racket, or from the direct blow of a club on the ground. This may result in ulnar nerve compression at the wrist in Guyon's canal, which is particularly exacerbated in the context of non-union due to secondary osteoarthritis or loose bodies in the pisotriquetral joint. Other causes of ulnar nerve compression at the wrist include adjacent masses, anomalous muscles and tendons, fibrous palmar arch, ulnar artery aneurysm, primary osteoarthritis of the pisotriquetral joint, os hamuli proprium and dislocation of the pisiform bone.



80) A 72-year-old woman presents to the rheumatologist with a long history of shoulder pain affecting her dominant arm that began at night with associated stiffness, but has suddenly worsened over the past few weeks. Radiographs show a superiorly subluxed humeral head forming a pseudarthrosis with the acromion, glenohumeral joint space loss, humeral head collapse with cysts and sclerosis, and periarticular soft-tissue calcification. Ultrasound scan demonstrates an effusion with widespread degeneration of the rotator cuff and a complete tear of the supraspinatus tendon. Examination of aspirated joint fluid shows calcium hydroxyapatite crystals. What is the most likely diagnosis?

- a. Milwaukee shoulder
- b. pseudogout
- c. myositis ossificans progressiva
- d. erosive osteoarthritis
- e. scleroderma

80) a. \*\*\*\*

Milwaukee shoulder is a crystal deposition disease of basic calcium phosphate, predominantly affecting elderly women and resulting in a dysfunctional shoulder from destruction of the rotator cuff. It is often bilateral but always involves the dominant side. Radiographic findings include superior subluxation of the humerus due to loss of the superior rotator cuff, often forming a pseudarthrosis with the clavicle or acromion. Glenohumeral degeneration manifests as sclerosis and collapse of the humeral head, joint space narrowing and osteophyte formation. Erosion at the site of rotator cuff insertion and periarticular soft-tissue calcification is also a feature. Examination of effusion fluid is stereotypical, revealing spheroid-shaped aggregates of hydroxyapatite crystals. The condition is also seen in the knee, where, unlike osteoarthritis, it predominates in the lateral compartment.

- 85) Radiographic arthrography of the shoulder with injection of contrast into the glenohumeral joint is performed for a painful joint with a globally reduced range of movement. Which single finding is most likely to indicate a diagnosis of adhesive capsulitis?
- Frozen Shoulder*
- a. pain on injection of contrast
  - b. small axillary recess
  - c. contrast tracking along the subscapularis muscle
  - d. contrast in the subacromial space
  - e. obliteration of the subcoracoid fat

85) b. \*\*\*

Adhesive capsulitis or frozen shoulder is clinically characterized by restriction of both active and passive elevation and external rotation. Patients are commonly 40–70 years old and predominantly female. It may be idiopathic, preceded by trauma, or associated with diabetes mellitus or other conditions. Patients have been shown to have a significantly thickened coracohumeral ligament and joint capsule, and an axillary recess significantly reduced in volume. Obliteration of the fat triangle between the coracohumeral ligament and the coracoid process is specific when seen on MR arthrography. Treatment options include physiotherapy, intra-articular corticosteroid injection, manipulation under anaesthetic and surgical capsulotomy.

86) A 45-year-old, right-handed, male mechanic presents to orthopaedic clinic with intermittent ulnar-sided wrist pain that is at its worst while he uses a screwdriver. Radiographs show positive ulnar variance with a normal ulnar styloid. Subsequent MRI reveals a central perforation of the triangular fibrocartilage complex with chondromalacic changes in the lunate. What is the most likely condition?

- a. ulnar impingement syndrome
- b. ulnar impaction syndrome
- c. ulnar styloid impaction syndrome
- d. hamatolunate impaction syndrome
- e. triangular fibrocartilage tear

86) b. \*\*\*

Ulnar-sided wrist pain is often caused by one of the spectrum of conditions known as impaction syndromes. These include ulnar impaction syndrome (most common), ulnar impingement syndrome, ulnocarpal impaction syndrome secondary to non-union of the ulnar styloid process, ulnar styloid impaction syndrome and hamatolunate impingement syndrome. Ulnar impaction syndrome is a degenerative condition secondary to excessive loading across the wrist and characteristically shows a positive ulnar variance that is accentuated in pronation and during a firm grip. MRI is used to identify complications such as triangular fibrocartilage complex tear or bone marrow oedema.

98) Following wrist arthrography by a single-compartment radiocarpal injection technique, contrast seen on MR arthrographic images in the midcarpal compartment can be explained by disruption of which of the following structures?

- a. triangular fibrocartilage
- b. lunotriquetral ligament
- c. dorsal distal radioulnar ligament
- d. flexor retinaculum
- e. radioscapulolunate ligament



98) b. \*\*

The two most important intercarpal ligaments are the scapholunate and lunotriquetral ligaments. These are crescent shaped with strong anterior and posterior zones and a relatively thin middle membrane. Disruption of either of these will result in communication of the radiocarpal compartment proximally with the midcarpal compartment distally. Contrast material seen in the distal radioulnar joint indicates disruption to the triangular fibrocartilage complex or distal radioulnar ligaments. Some authors advocate selective midcarpal injection as superior in delineating injury to the scapholunate and lunotriquetral ligaments, and a sequential technique of three injections has also been described.

- 5.) In a 65 year old woman with a fracture of the neck of the humerus, which of the following classification systems to describe the fracture would be useful in guiding the surgical management?
- a. Garden classification
  - b. Neer classification
  - c. Weber classification
  - d. Fryman system
  - e. Crosby-Fitzgibbon system

5. b. Neer classification

The Neer classification system is used to grade humeral neck fractures. This system describes four parts – greater tuberosity, lesser tuberosity, humeral head and shaft of humerus. According to Neer, a fracture is displaced if there is more than 1 cm of displacement and 45° angulation between any two segments. Two-part fractures involve any of the four parts and include one fragment that is displaced. Three-part fractures include a displaced fracture of the surgical neck in addition to either a displaced greater tuberosity or lesser tuberosity fracture. Four-part fractures include displaced fractures of the surgical neck and both tuberosities.

8. A 45 year old woman falls onto her outstretched hand. The following findings on PA and lateral wrist plain films indicate which pathology? A scapholunate angle of  $70^\circ$ , a capitolunate angle of less than  $20^\circ$ , and a 4 mm gap between scaphoid and lunate on PA view.
- Normal appearances
  - Scapholunate dissociation
  - Volar intercalated segment instability (VISI)
  - Dorsal intercalated segment instability (DISI)
  - Perilunate dislocation

**8. b. Scapholunate dissociation**

In scapholunate dissociation the scapholunate angle is  $>60^\circ$  and there is a  $>3$  mm gap between the scaphoid and lunate on AP view of the wrist. In VISI, capitolunate angle is increased and there is volar angulation of the lunate. In DISI, both scapholunate and capitolunate angles are increased and there is dorsal angulation of the lunate.

15. A 24 year old rugby player attends A&E following a tackle during which he felt his left shoulder dislocate. Initial plain radiographs confirm an anterior inferior dislocation of the left shoulder. Which of the following statements is true?
- The humeral head lies inferior and lateral to the glenoid on the AP view
  - The presence of a Hill-Sachs defect indicates previous dislocation
  - Hill-Sachs lesions are more common than Bankart lesions
  - Anterior dislocation accounts for 50% of shoulder dislocations
  - A Hill-Sachs lesion affects the inferior aspect of the humeral head

**15. c. Hill-Sachs lesions are more common than Bankart lesions**

A Hill-Sachs lesion affects the postero-superior aspect of the humeral head and whilst it does often indicate a previous dislocation, this is not necessarily the case and it can be present after a single episode. A Bankart lesion affects the inferior glenoid. Almost 95% of all shoulder dislocations are anterior.

39. A 72 year old woman presents to her GP with pain in her right shoulder which is worse on movement. Plain films of the right shoulder show loss of subacromial space and superior subluxation of the humeral head. She is referred for an ultrasound with a suspected supraspinatus tear. Which is the best position of the arm for visualisation of the free edge of the supraspinatous tendon?
- a. Adduction and internal rotation
  - b. Abduction and internal rotation
  - c. Adduction and external rotation
  - d. Abduction and external rotation
  - e. Flexion and internal rotation

**39. a. Adduction and internal rotation**

The best position for visualising the supraspinatous tendon is with the patient's arm in adduction and internal rotation. Often the patient may be asked to place the back of their hand onto their back, or alternatively asking them to simulate putting the hand into the back pocket of their trousers. The most medial part of the tendon when imaged transversely is the free edge – this is where the majority of supraspinatous tears occur.

48. Regarding scaphoid fractures, which of the following statements is correct?
- a. 80% of scaphoid fractures occur at the waist
  - b. Approximately 5% of scaphoid fractures are complicated by avascular necrosis
  - c. Injury is typically due to hyperextension
  - d. Up to 60% of scaphoid fractures cannot be seen on initial radiograph
  - e. The specificity of CT in diagnosing scaphoid fractures is 60–70%

**48. c. Injury is typically due to hyperextension**

The scaphoid bone is the most commonly fractured carpal bone and the mechanism is usually a fall onto the outstretched hand – ie. hyperextension of the wrist. The reported sensitivities and specificities of CT are 89–97% and 85–100%, respectively. The high negative predictive value of CT (96.8–99%) makes it very useful for ruling out a fracture. Scaphoid fractures are missed on initial radiographs in up to 30% of cases.



56. A 56 year old woman who has had chronic wrist pain since a fall several months previously is referred for an MR arthrogram of her wrist with a suspected triangular fibrocartilage complex (TFCC) tear. Which of the following would be the best sequence for visualising a TFCC tear?
- a. T1 axial
  - b. T2 coronal
  - c. Gradient echo sagittal
  - d. T2 sagittal
  - e. T1 sagittal

**56. b. T2 coronal**

The best sequence would be a T2 or T2\* image for detecting a tear. This is also a useful plane in which to assess for ulnar variance; positive ulnar variance has an association with perforations. The central portion of the articular disc is not well vascularised and therefore a tear in this portion will heal poorly. The peripheral portion, however, has been vascularised.

- 33 A football goalkeeper dived to the ground while making a save and experienced immediate pain in his wrist. The action replay shows forced hyperextension in ulnar deviation. Radiographs reveal no abnormality on the AP projection, but a subtle fracture on the lateral view. What bone is most likely to have been injured?
- a Capitate
  - b Hamate
  - c Lunate
  - d Pisiform
  - e Triquetral

**33 Answer E: Triquetral**

Triquetral fractures are common although easily missed on standard frontal projections. On a lateral projection an avulsed flake of bone lying posterior to the triquetral is typical. The usual mechanism of injury is falling onto an outstretched hand in ulnar deviation. A less common mechanism of triquetral fracture is a direct blow to the dorsum of the hand, which would usually be accompanied by other carpal fractures as a greater force is required. A fall onto an outstretched hand more commonly causes a scaphoid fracture although this is more likely in radial rather than ulnar deviation.

- 34 A skier fell on his outstretched hand with his hand caught in his ski pole and sustained an abduction injury of his thumb. His thumb was painful and swollen and he noticed that it felt unstable. He consulted a doctor in the resort who arranged radiographs of his hand and wrist. What is the most likely diagnosis?
- a Dislocation of carpo-metacarpal joint of thumb
  - b Soft-tissue injury only
  - c Scaphoid fracture
  - d Rupture of ulnar collateral ligament
  - e Dislocation of first metacarpophalangeal joint

34 Answer D: Rupture of ulnar collateral ligament

Chronic injury of this ligament is termed 'gamekeeper's thumb' but the acute form is now much more common and is termed 'skier's thumb' due to acute forceful abduction of the thumb usually when trapped in a ski pole. The ulnar collateral ligament originates from the first metacarpal head and may avulse a small fragment of bone from its proximal phalangeal insertion. Subluxation, but not usually frank dislocation, of this joint is seen and prompt consideration of surgical repair is indicated to prevent prolonged pain and functional impairment.

- 4 A 42-year-old secretary complains of pain and tingling in the radial three and one-half digits of the palmar surface of her right hand. Her symptoms began almost a year ago with nocturnal burning and tingling and have progressed since then. Her thenar eminence shows early wasting. An MRI of her wrist is arranged for further assessment. What features would be expected?
- a Increased signal intensity of the median nerve on T2WI
  - b Decreased signal of the median nerve on T1WI
  - c Dorsal bowing of flexor retinaculum
  - d Normal nerve diameter inside the carpal tunnel
  - e Thickening of the ligament of Struthers

4 Answer A: Increased signal intensity on T2WI

The pathogenesis of carpal tunnel is probably one of ischaemia with venous congestion and nerve oedema from anoxia of the capillaries followed by impairment of venous and arterial blood supply. There are multiple causes for carpal tunnel syndrome including physiological states such as pregnancy. Other radiological features include: 'pseudoneuroma' of median nerve, swelling of nerve within carpal tunnel, volar bowing of flexor retinaculum, tenosynovitis of tendon sheaths, enhancement of the median nerve due to oedema or alternatively no enhancement due to ischaemia from holding the wrist in a fixed flexed/extended position.

69 A 70-year-old man presented with shoulder pain and was assessed with ultrasound. He was found to have torn part of his rotator cuff. Which muscle was most likely to have been damaged?

- a Deltoid
- b Infraspinatus
- c Subscapularis
- d Supraspinatus
- e Teres minor

69 Answer D: Supraspinatus

Deltoid is not part of the rotator cuff. Supraspinatus is most frequently injured at or close to its insertion into the humerus.

24 A young girl attended the Emergency Department after tripping over and falling onto her outstretched hand. Clinical examination revealed bruising and swelling on the palmar surface of her hand and she was exquisitely tender in the 'anatomical snuff box'. What would be the best investigation to exclude a scaphoid fracture?

- a Immediate plain radiography including scaphoid views
- b Plain radiography including scaphoid views after 10 days
- c Bone scan within 24 hours
- d MRI within 24 hours
- e Unenhanced CT

**24** Answer D: MRI within 24 hours

There is still some controversy over whether MRI or scintigraphy are the most sensitive modalities for scaphoid fracture detection, but most authorities would accept that imaging within 24 hours is optimal and scintigraphy is most sensitive at 4–5 days post-injury.

**26** A 10-year-old boy fell off a climbing frame onto the ground and injured his left elbow. He was assessed in the Emergency Department, and AP and lateral radiographs of his elbow were taken. What finding would be indicative of a fracture?

- a The anterior humeral line passing through the middle third of the capitellum on a lateral view
- b Non-visualisation of the lateral epicondyle
- c Visible anterior fat pad
- d Visible posterior fat pad
- e The radiocapitellar line intersecting the centre of the capitellum

**26** Answer D: Visible posterior fat pad

Elevation of the anterior fat pad is abnormal, but it is often visible without

elevation as it sits in the shallow coronoid fossa of the humerus. Visualisation of the posterior fat pad is almost always abnormal, as it normally lies hidden within the deeper olecranon fossa.

- 27 An elderly woman tripped on the edge of the curb and fell to the ground. She prevented herself from hitting her head by putting her right hand out in front of her. Her past history was unremarkable other than osteoporosis diagnosed on a DEXA scan two years previously. Immediately after the injury she noticed pain and restricted movement in her right arm. What injury is most likely to be visible on radiographs of the humerus and shoulder?
- a Supracondylar fracture of humerus
  - b Posterior dislocation of shoulder joint
  - c Fracture of anatomical neck of humerus
  - d Fracture of deltoid tuberosity of humerus
  - e Fracture of surgical neck of humerus

27 Answer E: Fracture of surgical neck of humerus

The most likely injury in this context of falling on an outstretched arm, particularly in a patient with an osteoporotic humerus, is a fracture of the surgical neck, which is the point of weakness and is most easily fractured by an axial force. A fracture of the deltoid tuberosity is rare and would usually only occur with an avulsion by the deltoid tendon. The anatomical neck is not commonly fractured. Posterior dislocations are not common, occurring classically in the context of an epileptic fit or electrocution.

- 29 A 48-year-old female complained of pain in the ulnar aspect of her wrist with no specific antecedent history. Examination did not elicit any positive findings and she was referred for an MRI of her wrist. The only significant finding was a linear band of high signal in a structure just distal to the ulnar styloid that was otherwise of uniformly low signal on both T1- and T2-weighted images. What structure is most likely to have been damaged?
- a Triquetral bone
  - b Triangular fibrocartilage
  - c Extensor carpi ulnaris tendon sheath
  - d Luno-triquetral ligament
  - e Proximal surface of lunate bone

**29 Answer B: Triangular fibrocartilage**

Injuries to the TFC are a frequent cause of ulnar-sided wrist pain. The ulnar side of the wrist is supported by the TFC, which articulates with the lunate and triquetral distally. Tears are most commonly associated with a positive ulnar variance but may occur as a result of direct trauma; for example forced ulnar deviation on hitting a ball with a cricket bat. The extensor carpi ulnaris tendon sheath, dorsal and volar radioulnar ligaments and ulnocarpal ligaments are all part of the TFC complex. However, it is the TFC proper (articular disc) that is the most commonly injured structure in the complex.

- 35** A teenager was brought to the Emergency Department after feeling the sensation of his right shoulder 'popping out'. He was unable to use his right arm and radiographs confirmed an anterior dislocation. Which nerve should be specifically examined to exclude an associated injury?
- a Musculocutaneous nerve
  - b Lateral plantar nerve
  - c Dorsal scapular nerve
  - d Radial nerve
  - e Axillary nerve

**35 Answer E: Axillary nerve**

Axillary nerve function is assessed pre- and post-shoulder relocation by testing for sensation in the 'regimental patch' area of skin in the upper arm and deltoid power (shoulder abduction). The nerve is at risk of damage from a dislocated humeral head where it lies close to the inferior joint capsule.

- 67** An active 22-year-old man presented with shoulder pain following an injury playing rugby. He was found to have an anterior dislocation of his glenohumeral joint. What associated injury to the glenoid labrum is likely?
- a Hill-Sachs lesion
  - b Reverse Hill-Sachs defect
  - c Bankart lesion
  - d Reverse Bankart lesion
  - e SLAP (Superior labral anterior to posterior) lesion



**67 Answer C: Bankart lesion**

This is a tear of the anterior glenoid labrum and may be associated with a Hill Sachs defect in the posterolateral surface of the humeral head.

**7. A 34-year-old female presents to the A&E department after falling on an outstretched hand. Examination reveals tenderness at the anatomic snuff box. A scaphoid radiograph series confirms scaphoid fracture. Which of the following features is most associated with a poor prognosis?**

- A. Fracture of the distal third.
- B. Fracture of the middle third.
- C. Fracture of the proximal third.
- D. Horizontal oblique fracture orientation.
- E. Displacement of the scaphoid fat stripe.

**7. C. Fracture of the proximal third.**

Scaphoid fracture is the most common of all carpal bone fractures and also potentially serious due to the high rate of avascular necrosis. This fracture can be difficult to detect on initial radiographs. Wrist casting and repeat radiography after 1 week are typically advised if there is ongoing suspicion. Fractures of the proximal third account for 20% of injuries, but are associated with failure to unite in 90%. Middle third fractures make up the majority (70%), with up to 30% failing to reunite. Distal third fractures usually reunite. A vertical oblique fracture is more unstable than a horizontal oblique fracture. Fracture displacement of greater than 1mm is also a poor prognostic feature.

**10. A 24-year-old male presents to the A&E department with pain and swelling of his right thumb after landing against his ski pole while practising at the local dry ski-slope. An avulsion fracture at the base of the proximal phalanx is noted on a radiograph of the thumb. What underlying soft tissue structure has been injured to result in this fracture?**

- A. Ulnar collateral ligament.
- B. Radial collateral ligament.
- C. Joint capsule.
- D. Flexor pollicis longus tendon.
- E. Extensor pollicis longus tendon.

**10.A. Ulnar collateral ligament.**

The history and radiographic findings are typical of gamekeeper's thumb, which is an injury to the ulnar collateral ligament at its insertion site into the proximal phalanx of the thumb. This injury usually requires internal fixation to secure the ligament. Radial collateral ligament injuries of the thumb lead to painful deformity and articular degeneration. Rupture of flexor pollicis longus results in loss of active flexion of the thumb. The thumb remains in flexion with rupture of extensor pollicis longus. Thumb tendon injuries are typically seen in RA due to their susceptibility to synovitis.

**12. You are carrying out an MRI on a patient with a known history of RA.**

The patient has minimal erosions on plain film, but severe arthralgia. She is being considered for biologic therapy. The clinicians have requested an MRI of her hands. This reveals symmetrical disease in both hands with areas of high signal on T2WI and low signal on T1WI around the triangular fibrocartilage complex (TFCC), the radio-carpal joint (RCJ), and the distal radio-ulnar joint (DRUJ). The abnormal areas at the TFCC and RCJ enhance following administration of gadolinium, the DRUJ does not. A delayed T1WI sequence displays uniform enhancement in all joints. What do these findings indicate?

- A. Hypervascular pannus at the TFCC and RUJ, with fibrous pannus at DRUJ.
- B. Fibrous pannus at the TFCC and RUJ, with joint effusion at DRUJ.
- C. Hypervascular pannus at the TFCC and RUJ, with joint effusion at DRUJ.
- D. Fibrous pannus at the TFCC and RUJ showing differential enhancement.
- E. Fibrous pannus at the TFCC and RUJ with hypervascular pannus at DRUJ.

**12. C. Hypervascular pannus at the TFCC and RUJ, with joint effusion at DRUJ.**

Hypervascular pannus is intermediate to high signal on T2WI and low signal on T1WI. It also enhances, retaining enhancement on delayed imaging. Joint effusions can be difficult to differentiate from hypervascular pannus on pre-contrast imaging. Following enhancement they show only delayed enhancement. Fibrous pannus is low signal on all sequences.



**15. A 39-year-old male presents with tenderness and decreased range of movement of the right elbow after falling on an outstretched arm while playing indoor football. A radial head fracture is noted on his radiographs, but the A&E doctor asks for your opinion, suspecting an additional injury. What is the most common associated fracture with this injury?**

- A. Olecranon fracture.
- B. Coronoid process fracture.
- C. Scaphoid fracture.
- D. Proximal ulna fracture.
- E. Capitellum fracture.

**15. B.** Coronoid process fracture.

Radial head fractures are common, accounting for approximately one-third of all elbow fractures and up to 5% of all fractures in adults. A recent retrospective study found that associated fracture of the upper extremity was seen in 10.2% of patients, with fractures of the coronoid process the most common (4.1%). Radial head fracture, coronoid fracture, and medial collateral ligament tear form the 'terrible triad' of the elbow, which requires operative fixation.

**30. A 21-year-old rugby player presents to the A&E department with right shoulder pain and decreased range of movement following a tackle. There is obvious contour deformity on examination. Plain radiographs confirm anterior dislocation. Which additional radiographic finding is in keeping with a Hill–Sachs deformity?**

- A. Intra-articular loose body.
- B. Greater tuberosity fracture.
- C. Anterior glenoid rim fracture.
- D. Anterior humeral head indentation.
- E. Posterior humeral head indentation.

**30. E.** Posterior humeral head indentation.

Anterior dislocation occurs when the arm is forcibly externally rotated and abducted. Radiographically, the humeral head lies inferior and medial to the glenoid on the AP view. The Hill–Sachs deformity is an indentation on the posterosuperior portion of the humeral head and indicates a greater likelihood of recurrence. A Bankart deformity is a bony fragment off the inferior glenoid. Anterior humeral head indentation is a 'reverse Hill–Sachs' deformity seen in posterior dislocations.

**35. A 26-year-old man presents to the A&E department with wrist pain and swelling after falling from a ladder on an outstretched hand. The lateral radiograph demonstrates posterior dislocation of the capitate relative to the lunate. What is the most commonly associated fracture with this injury?**

- A. Capitate.
- B. Lunate.
- C. Triquetral.
- D. Scaphoid.
- E. Radius.

**35. D. Scaphoid.**

The findings describe perilunate dislocation, which is the most common carpal dislocation. It can occur without fracture (lesser arc injury) or with fracture (greater arc injury). Greater arc injuries are twice as frequent as lesser arc injuries. When describing these injuries the fracture is named first with the prefix 'trans' followed by the dislocation. Trans-scaphoid perilunate dislocation is the most common type of perilunate injury. Fractures of the trapezium, capitate, hamate, and triquetrum are also part of the greater arc injuries. Other radiographic signs of this injury include disruption of the carpal (Gilula) arcs and a triangular lunate on the AP view. An early sign is widening of the scaphoid-lunate space (Terry-Thomas sign), which suggests scapholunate dissociation. Lunate dislocation is the final stage of perilunate injuries, and is associated with the highest degree of instability.

**45. A 56-year-old woman is referred for MR arthrography of her right shoulder for query rotator cuff tear. You are asked to explain the procedure to a group of medical students attached to the department. What is the advantage of using a fat-suppressed T1WI sequence?**

- / A. Differentiating partial from full thickness tear.
- B. Identify bursal fluid collections.
- C. Differentiating inadvertent air injection from intra-articular loose body.
- D. Diagnosing capsular laxity.
- E. Detecting incidental bone marrow lesions.

**45.A.** Differentiating partial from full thickness tear:

MR arthrography is most helpful for outlining labral-ligamentous abnormalities in the shoulder and distinguishing partial thickness from full thickness tears in the rotator cuff. The technique involves injection of diluted gadolinium mixed with iodinated contrast, which allows fluoroscopic confirmation of intra-articular needle placement. Partial and full thickness tears may not be distinguishable on standard T1WI because fat and gadolinium have similar signal intensities. This is especially the case when cuff tendons show contrast solution extending to the bursal surface but not definitively through it. This problem can be overcome with use of fat suppression. MR arthrography should include a T2WI sequence to identify bursal fluid collections and tears.

T2WI is also helpful in characterizing incidental bone marrow lesions. Inadvertent injection of gas may lead to a false-positive diagnosis of intra-articular loose bodies, but gas bubbles will rise to non-dependent regions, whereas loose bodies will gravitate to dependent locations. No accurate MR imaging criteria are recognized in the diagnosis of capsular laxity.

**48. A 34-year-old woman has chronic right wrist pain, with no documented history of previous trauma. An x-ray of the right wrist shows sclerosis and irregularity of the scaphoid with early bony fragmentation. What is the most likely eponymous disease that has resulted in this abnormality?**

- A. Sever disease.
- B. Freiberg disease.
- C. Kohler disease.
- D. Iselin disease.
- ✓ E. Preiser disease.

**48.E.** Preiser disease.

The x-ray appearances are typical for osteonecrosis within the scaphoid. This is usually post-traumatic in aetiology, but when idiopathic it is known as Preiser disease. Postulated mechanisms for the osteonecrosis are repetitive minor trauma or secondary to drug treatment (e.g. steroids).

The remaining wrong answers refer to osteochondroses affecting the foot. Freiberg disease affects the head of the second metatarsal, Kohler disease the tarsal navicular, Iselin disease the base of the fifth metatarsal and Sever disease the calcaneal apophysis.



- 11 A 32 year old man presents with a painful elbow, having fallen off his bicycle. AP and lateral radiographs of the elbow are taken; an A&E doctor is unsure if an abnormality is present and phones to ask your advice.

Which of the following indicates an underlying abnormality?

- (a) A visible anterior fat pad
  - (b) On the lateral view, a line drawn through the long axis of the proximal radius passes through the capitellum
  - (c) The posterior fat pad is not visible
  - (d) 'Hourglass' or 'figure 8' sign of the distal humerus on lateral film
  - ✓ (e) The anterior humeral line passes through the anterior third of the capitellum.
- More than one third of capitellum should lie ant to ant humeral line, if not → a supracondylar fr should be suspected*

11 (e)

More than one third of the capitellum should lie anterior to the anterior humeral line – if not, a supracondylar fracture should be suspected. A visible posterior fat pad is always abnormal. Displacement of the anterior fat pad raises the possibility of a fracture. In a true lateral film the distal humerus appears to form an 'hourglass', loss of this or apparent asymmetry are indicators of a supracondylar fracture.

- 24 A 32 year old man falls on his outstretched right wrist whilst playing football. Wrist X-ray reveals a displaced, oblique intra-articular fracture of the dorsal lip of the distal radius.

What is the fracture type described?

- ✓ (a) Barton's
- (b) Chauffeur's
- (c) Colles'
- (d) Smith's
- (e) Salter Harris Type II



**24 (a)**

A Barton's fracture refers to an intra-articular fracture through the distal radius. The conventional Barton fracture involves the dorsal rim of the radius, the reverse Barton involves the volar rim. Salter-Harris fractures involve the growth plate before closure; the other types described are not intra-articular. Colles' and Smith's are fractures of the distal radius with dorsal and volar displacement of the distal fragments, respectively. A chauffeur fracture is a triangular fracture of the radial styloid process.

**31 Plain radiographs are taken of a 9 year old's elbow. Five ossification centres are seen.**

**Which of the visible ossification centres would have been last to appear?**

- (a) Radial head
- (b) Lateral epicondyle
- (c) Medial epicondyle
- (d) Olecranon
- (e) Trochlear

**31 (d)**

Although there can be some variation in the order, the usual sequence of appearance is shown below:

Approximate age at appearance (years)	Ossification centre
1	Capitellum
3	Radial head
4–5	Internal (medial) epicondyle
7–8	Trochlea
8–10	Olecranon
9–13	Lateral (external) epicondyle

- 36 A patient has injured his right shoulder. An AP view demonstrates an acromio-clavicular distance of 12 mm and a coraco-clavicular distance of 10 mm. The clavicle is not otherwise grossly displaced.

What is the grade of the acromio-clavicular joint injury?

- (a) Grade I → normal radiograph  
 (b) Grade II → A-C > 8-10 mm CC ≤ 13 mm  
 (c) Grade III → A-C > 8-10 mm CC > 13 mm  
 (d) Grade IV → Total dislocation, clavicle is dislocated into trapezius  
 (e) Grade V → Total dislocation, clavicle is dislocated into neck  
 Grade VI → Total dislocation, clavicle is dislocated inferiorly

Grade	Features
I	Normal radiograph
II	AC distance > 8–10 mm; CC distance ≤ 13 mm
III	AC distance > 8–10 mm; CC distance > 13 mm
IV	Total dislocation, clavicle dislocated into trapezius
V	Total dislocation, clavicle dislocated into neck
VI	Total dislocation, clavicle dislocated inferiorly

- 38 A patient presents with tenderness in the anatomical snuffbox and a scaphoid series of plain radiographs are taken. There is a fracture across the proximal pole of the scaphoid.

Which of the following is incorrect?

- (a) Compared to other scaphoid fractures, those across the proximal pole have the highest risk of avascular necrosis  
 (b) Most scaphoid fractures occur across the waist  
 (c) Most scaphoid fractures are not displaced  
 (d) Scaphoid waist fractures may take up to 2 years to heal  
 (e) A vertical oblique fracture is considered more stable compared to a transverse fracture

• Most proximal pole fractures  
 • 80% of #  
 • cross up to waist of scaphoid

**38 (e)**

Fractures across the proximal pole and waist both carry a high risk of subsequent AVN. 80% of fractures occur across the waist, compared to 10% for each of the poles. Transverse/horizontal oblique fractures are relatively stable compared to vertical oblique fractures.

**45 An MR arthrogram of the shoulder is performed in a patient with a known history of shoulder dislocation.**

**Which of the following features would be more supportive of prior posterior, rather than anterior, glenohumeral dislocation?**

- (a) Hill-Sach's lesion
- (b) Anterior labral tear
- (c) Torn glenohumeral ligaments
- (d) Posterior capsule stripping
- (e) Bankart lesion

**45 (d)**

Posterior dislocations produce posterior, rather than anterior, capsule stripping. Other evidence of a prior posterior dislocation include: a reverse Bankart lesion, a reverse Hill-Sach's lesions, or a posterior labral tear.

**7 A 20 year old man presents after a fall with anatomical snuff box tenderness.**

**Which of the following statements is incorrect?**

- (a) 40% of scaphoid fractures are visible on initial radiographs
- (b) Interval radiographs at 7–10 days detect the majority of initial occult fractures
- (c) The MRI sequences of choice are coronal T1 and STIR
- (d) 80% of fractures occur through the waist of the scaphoid
- (e) Distal radius fractures can present in this manner

**7 (a)**

85% of scaphoid fractures are detectable initially using scaphoid views. Repeat views are commonly obtained but detection of occult fractures are unreliable. Nuclear imaging is sensitive but non-specific. MRI is the best test for detection of occult fracture. However, lack of availability means that other tests are still used.

**32 A 32 year old workman presents with wrist pain. Plain radiographs show sclerosis and deformity of the lunate.**

**Which of the following statements is incorrect?**

- (a) This condition is more common on the right
- (b) There is an association with positive ulnar variance
- (c) Despite the presence of pain, the radiographs can initially be normal
- (d) Scapholunate separation is a complication
- (e) It is more commonly bilateral

**32 (b)**

AVN of the lunate (Kienbock's disease) is associated with negative ulnar variance in 75%. Manual labour is a predisposing factor. Other complications include ulnar deviation of the triquetrum and degenerative joint disease in the radiocarpal and midcarpal compartments.

- 50 An epileptic patient complains of left shoulder pain after a seizure. A posterior dislocation is suspected.**

**Which part of the humeral head is at risk of a compression fracture?**

- (a) Anteromedial
- (b) Anterolateral
- (c) Posteromedial
- (d) Posterolateral
- (e) Surgical neck

**50 (a)**

This is the 'trough' sign also known as a 'reverse Hill-Sachs' lesion and is caused by contact against the posterior glenoid labrum during posterior dislocation.

- 51 A patient presents with wrist pain subsequent to a fall. Carpal instability is suspected and a lateral radiograph is taken of the wrist in neutral alignment. The scapholunate angle is 70° and the capitolunate angle is 10°.**

**What is the most appropriate description?**

- (a) Normal
- (b) Scapholunate dissociation
- (c) Volar intercalated segment instability
- (d) Dorsal intercalated segment instability
- (e) Scapholunate advanced collapse

**51 (b)**

Classification	Scapholunate angle	Capitolunate angle
Normal	30–60°	≤ 20°
Scapholunate dissociation	> 60°	≤ 20°
Volar intercalated segment instability	< 30°	> 20°
Dorsal intercalated segment instability	> 60°	> 20°

**54 A wrist radiograph in a child demonstrates a carpal angle of 110°.**

**Which of the following is not a recognised cause?**

- (a) Hurler's syndrome
- (b) Down's syndrome
- (c) Madelung deformity
- (d) Turner's syndrome
- (e) Morquio's syndrome

**54 (b)**

The carpal angle is formed by two tangential lines, the first drawn between the proximal scaphoid and lunate, and the second between the triquetrum and lunate. It has a normal range of 130–137° in the adult and normal ranges have been derived for children of different ages. Down's syndrome is associated with an increased carpal angle (>139°) along with other conditions such as arthrogryposis.





49) Tarsal coalition is a common cause of foot pain. Which of the following joints is most commonly affected?

- a. anterior subtalar
- b. middle subtalar
- c. posterior subtalar
- d. calcaneonavicular
- e. calcaneocuboid

49) d. \*\*\*

MRI is valuable in the diagnosis of a number of musculoskeletal conditions of the ankle, including osteochondral lesions of the talus, bone infarcts and bruising, stress fractures, osteoid osteoma and tarsal coalition. Forty-five per cent of tarsal coalition occurs at the calcaneonavicular joint, with a further 45% at the subtalar joint, most commonly involving the middle facet. Radiographic findings include joint space narrowing, indistinct articular margins, elongation of the anterior calcaneus, a hypoplastic talus and reactive sclerosis of the involved bones. It is commonly associated with pes planus. Treatment options include physical supports, anti-inflammatory medication, local steroid injection, and surgical resection or arthrodesis.

71) On MRI of the foot performed for non-specific pain, which single feature is most specific for a diagnosis of sinus tarsi syndrome?

- a. subtalar joint effusion
- b. subtalar sclerosis
- c. loss of fat signal in the sinus
- d. bone marrow oedema in the talus
- e. flexor tendon high signal on T2W images

71) c. \*\*\*\*

Sinus tarsi syndrome is a common complication of ankle sprains, but may also result from an inflammatory arthropathy. It is associated with abnormalities of one or more structures in the tarsal sinus and tarsal canal that lead to pain and a feeling of instability of the hindfoot. Most patients with this syndrome present in the third or fourth decade of life with persistent lateral foot pain, though the pathogenesis of the condition is poorly understood. Conventional radiography generally is not valuable, but on MRI there is alteration of the fat signal, the most common changes being diffuse low-signal-intensity infiltration on both T1W and T2W images. Other common MR findings include synovial thickening and diffuse enhancement of the tarsal sinus following intravenous gadolinium.

19. A 50 year old woman presents with a mass on the plantar aspect of her right foot. Ultrasound reveals a small oval-shaped lesion between the plantar portions of the metatarsal heads. MRI characteristics of the lesion are low-to-intermediate signal on T1 and low signal intensity on T2. Which of the following is the most likely diagnosis?
- a. Lipoma
  - b. Morton's neuroma
  - c. Plantar fibromatosis
  - d. Giant cell tumour of the tendon sheath
  - e. Ganglion cyst

19. b. Morton's neuroma

The description is that of a Morton's neuroma. This occurs most commonly in the third metatarsal space and less commonly in the second space. There is often an associated metatarsal bursitis which is a high signal on STIR imaging. Ultrasound is usually the first imaging modality; squeezing the metatarsal heads together during scanning will usually make the lesion more prominent.

36. A 56 year old woman slips off the pavement onto the road and her outstretched foot is run over by a passing car. She has immediate severe midfoot pain. Plain radiographs taken on arrival at the emergency department confirm a Lisfranc fracture dislocation of the midfoot. Which two bones does the Lisfranc ligament attach to?
- a. First metatarsal and intermediate cuneiform
  - b. First metatarsal and medial cuneiform
  - c. Second metatarsal and medial cuneiform
  - d. Second metatarsal and intermediate cuneiform
  - e. First and second metatarsals to the medial and intermediate cuneiforms

**36. c. Second metatarsal and medial cuneiform**

The Lisfranc ligament attaches between the second metatarsal and medial cuneiform, which is why an injury to this ligament allows the second to fifth metatarsals to drift laterally once they have lost this stabilisation. This is therefore an unstable injury and requires rapid immobilisation. This is a vital injury to detect as long-term sequelae will often result from a delayed diagnosis.

58. A 53 year old woman attends A&E with a short history of dull right heel pain. She is otherwise fit and well and there is no history of trauma. Plain radiographs of the right foot and ankle reveal a 2 cm expansile non-aggressive lesion in the calcaneum. It has a thin, well-defined sclerotic border. There is no periosteal reaction but there is a small calcified central nidus. The most likely cause of the lesion is:
- a. Aneurysmal bone cyst
  - b. Intra-osseous lipoma
  - c. Lipoblastoma
  - d. Fibrous dysplasia
  - e. Desmoplastic fibroma

**58. b. Intra-osseous lipoma**

The calcaneum is a common location for an intra-osseous lipoma. They do, however, also occur in the extremities, skull and mandible. There is no periosteal reaction unless there is an associated fracture. Imaging features would be similar to those of a unicameral bone cyst. They are often asymptomatic but can present with localised bone pain.



- 25 A 20-year old man jumped 30 feet from a building onto concrete and landed on his feet. He was assessed in the Emergency Department and complained only of severe pain in his feet. He remained haemodynamically stable and after a full assessment it is clear that his only injuries are to his feet. What injury is he most likely to have sustained?
- a Osteochondral fracture of talar dome
  - b March fractures of second and third metatarsals
  - c Comminuted calcaneal fractures
  - d Maisonneuve fracture
  - e Transverse fracture of fifth metatarsal

25 Answer C: Comminuted calcaneal fractures

Predictable patterns of injury after a fall from a height include: calcaneal, pelvic and thoraco-lumbar spine fractures. A Maisonneuve fracture is a proximal fibular fracture commonly associated with a medial malleolar avulsion fracture.

- 28 A woman with poorly controlled diabetes mellitus fell down the stairs feet first. She did not experience much pain but found it difficult to walk after the fall and visited the Emergency Department where a doctor noticed that her ankle joint appeared abnormal with a large haematoma on the medial aspect of her foot. Neurological examination demonstrated bilateral sensory impairment in a stocking distribution. What injury is she most likely to have sustained?
- a Osteochondral fracture of the talar dome
  - b Fracture of the medial malleolus
  - c Maisonneuve fracture
  - d Lisfranc fracture-dislocation
  - e Pilon fracture

**28 Answer D: Lisfranc fracture-dislocation**

A fracture of the first or second metatarsal in conjunction with a dislocation of the tarso-metatarsal articulation is termed a Lisfranc fracture-dislocation. Such injuries usually require a significant force. A fracture of the medial malleolus usually occurs as a result of an inversion injury. A fracture of the proximal fibula (with disruption of the proximal talofibular syndesmosis) in conjunction with a fracture of the medial malleolus is termed a Maisonneuve fracture. Diabetics are at risk of peripheral neuropathy and subsequent injury due to lack of sensation and the commonest cause of a Charcot joint in the Western world is diabetes.

- 29** A 44-year-old man had an accident in which he was thrown from a motor-cycle. He landed on his left foot, which folded beneath him. On the day of the injury, his foot was examined and standard AP and lateral radiographs revealed no fracture. The foot was placed in slight plantar flexion and immobilised with a cast. After three days, the patient was re-evaluated and his foot remained oedematous. Ecchymoses was noted laterally and he could not weight-bear. What injury is he most likely to have sustained?

- a No bony or ligamentous injury is likely
- b Torn ligament between the second metatarsal and medial cuneiform
- c Transverse fracture through base of fifth metatarsal
- d Fracture of second metacarpal associated with dislocation of the tarsometatarsal joint
- e Fracture of medial malleolus

**29 Answer B: Torn ligament between the second metatarsal and medial cuneiform**

An injury to the Lisfranc joint most commonly occurs at the joint involving the first and second metatarsals and the medial cuneiform. The Lisfranc ligament is the only ligament connecting the second metatarsal to the medial cuneiform and may be torn with a Lisfranc injury. While transverse ligaments connect the bases of the lateral four metatarsals, no transverse ligament exists between the first and second metatarsal bases. The joint capsule and Lisfranc ligament form the only minimal support on the dorsal surface of the Lisfranc joint. As many as 20% of Lisfranc joint injuries are missed on initial anteroposterior and oblique radiographs.



- 1 A 40-year-old female presents with a three-month history of headaches and a visual field defect. An MRI of the sella turcica diagnosed a growth hormone-secreting pituitary adenoma. Which of the following findings would you expect on plain radiography?
- a Heel pad thickness >25 mm
  - b Opacification of paranasal sinuses
  - c Thinned skull vault
  - d Reduction in size of vertebral bodies
  - e Increased cortical thickness of long bones

1 Answer A: Heel pad thickness >25 mm

The underlying condition is acromegaly, indicated by the bitemporal hemianopia and excess growth hormone secretion. Normal heel pad thickness is <21 mm. Although heel pad thickness is not limited to acromegaly, it is the only condition in the list that is caused by a pituitary tumour. The list can be remembered by 'MAD COP' = Myxoedema, Acromegaly, Dilantin (phenytoin) therapy, Callus, Obesity, Peripheral oedema.

- 2 A 17-year-old female presented with foot pain on walking. Plain films showed a well-defined cystic lesion in the second metatarsal head. What is a plain film six months later likely to show?
- a Cortical thinning
  - b Sclerosis and flattening of the second metatarsal head
  - c Sclerosis of the other metatarsals
  - d Subluxation of the metatarsal heads
  - e Bony erosions in the metatarsal heads

2 Answer B: Sclerosis and flattening of the metatarsal head

The scenario described is of Freiberg disease, osteochondrosis of the head of the second (third and fourth) metatarsal heads in 10–18 year olds, usually women (M:F 1:3). Clinically they present with metatarsalgia, swelling and tenderness. Early and late features are seen. Early on, flattening and cystic lesions of the metatarsal head are seen, with widening of the metatarsophalangeal joint. Late features include: an osteochondral fragment, sclerosis and flattening of the bone and increased cortical thickening.

- 18 A 50-year-old man presented with foot pain and radiographs showed involvement of a number of joints with generally non-specific findings. What underlying diagnosis would the presence of periostitis favour?
- a Gout
  - b Pseudogout
  - c Psoriatic arthritis
  - d Haemophilia
  - e Rheumatoid arthritis

18 Answer C: Psoriatic arthritis

Other causes are juvenile rheumatoid arthritis, infectious arthritis and Reiter's syndrome.

- 19 A 19-year-old woman was investigated for foot stiffness and was found to have a tarsal coalition. What type of coalition is she most likely to have?
- a Calcaneocuboid
  - b Calcaneonavicular
  - c Cubonavicular
  - d Cuneometatarsal
  - e Talonavicular

19 Answer B: Calcaneonavicular

Calcaneonavicular and talocalcaneal coalitions each account for approximately 45%.

- 8 A 74-year-old man with gout presented with recurrent foot pain and an X-ray of both his feet was taken. What is a typical feature of a joint affected by gout?
- a Joint space preserved until late in disease
  - b No joint effusion
  - c Periarticular demineralisation
  - d Erosions with thick sclerotic margins
  - e Chondrocalcinosis in the majority of cases

**8** Answer A: Joint space preserved until late in disease

Gout is a disorder of purine metabolism, typically in middle-aged males, with four main parts: hyperuricaemia, deposition of positively birefringent crystals in synovial fluid, deposits of sodium urate in periarticular soft tissues, recurrent episodes of arthritis. It can be primary or secondary. The gouty tophus is pathognomonic histologically. The stages are: asymptomatic hyperuricaemia, acute gouty arthritis, chronic tophaceous gout and gouty nephropathy. Forty-five per cent of affected patients have radiological features, but these features are not seen until 6–12 years after the initial attack. Common locations are: joints, particularly hands and feet, bones, external ear. In the joint, effusion is the earliest sign, with periarticular swelling and preservation of joint space until late in the disease. The attacks are

short so there is no periarticular demineralisation. Eccentric erosions are also seen, particularly at the metacarpal bases. Chondrocalcinosis is only seen in 5%.

**19** An 18-year-old boy presented with foot pain and was diagnosed with a talocalcaneal coalition. What sort of coalition is most likely?

- a Bony union across anterior facet
- b Fibrous coalition across anterior facet
- c Bony union across middle facet
- d Fibrous coalition across middle facet
- e Fibrous union across posterior facet

**19** Answer C: Bony union across middle facet

Tarsal coalition is an abnormal fibrous, cartilaginous or osseous fusion of two or more tarsal bones. It affects 1–2% of the population and is thought to be present at birth with a fibrous band, which later ossifies leading to diagnosis in late teens/early adulthood. It is generally an incidental finding, but can be associated with hindfoot pain. MR can distinguish between cartilaginous and bony unions.

**42. An 81-year-old male diabetic is referred from the endocrinology team for an MRI of foot. This patient was seeing a podiatrist, who became concerned that the foot had become increasingly deformed and was acutely red and swollen around the tarso-metatarsal joints. The patient is asymptomatic as he has peripheral neuropathy. The clinical query is whether this patient has osteomyelitis/septic arthritis in this region, or neuropathic arthropathy. Which of these MRI features would be more typically associated with osteomyelitis than acute neuropathic arthropathy?**

- A. Focal involvement.
- B. Predominant midfoot involvement.
- C. Associated bony debris.
- D. High T2WI and STIR, low T1WI. Enhancement present.
- E. Bony changes are in a periarticular and subchondral location.

**42.A.** Focal involvement.

Whilst differentiating these conditions can be difficult and they frequently overlap, there are certain features that can be of value. Neuropathic arthropathy (NA) seldom affects a single bone/joint in the foot, and is most common in the midfoot region. As such a more focal abnormality, or abnormality affecting the metatarsal heads, or other points of pressure, should indicate osteomyelitis. Whilst high T2WI/STIR, low T1WI and enhancement are seen in osteomyelitis, it is also seen in acute NA and as such is not a good differentiating factor. The converse is not true, where low signal on T1WI and T2WI, typical of chronic NA, would make the presence of osteomyelitis unlikely.

**46. A 40-year-old female presents with a small lump in her foot. An MRI of the foot demonstrates a small soft tissue mass, which has homogenous low signal on T1WI and T2WI. The mass enhances with gadolinium. What is the most likely diagnosis?**

- A. Morton's neuroma.
- B. Lipoma.
- C. Ganglion cyst.
- D. Plantar fibromatosis.
- E. Hemangioma.



**46. D. Plantar fibromatosis.**

Fibrous masses containing mature collagen are homogeneously low in signal on T1WI and T2WI sequences, and demonstrate enhancement with gadolinium. Common fibrous masses in the foot are plantar fibromatosis and fibroma of the tendon sheath.

Morton's neuroma is typically intermediate in signal on T1WI and low on T2WI with variable contrast enhancement. Lipomas follow fat signal intensity. They are high on T1WI and T2WI, and low on fat-suppressed sequences. A ganglion cyst follows fluid signal. Ganglion cysts are low on T1WI and high on T2WI with rim enhancement. Haemangiomas are of mixed signal on T1WI and T2WI due to the presence of vessels, fat, and fibrous tissue. The vascular portions of hemangiomas enhance homogeneously.

**52. A 24-year-old male patient is referred from the rheumatologists with a history of back pain and hip pain. Plain films are carried out. These show bilateral sacroiliitis with erosive change on the iliac side on the left, but sacral and iliac erosions on the right. The imaging of the spine reveals large non-marginal syndesmophytes in the thoracolumbar spine with a relatively normal lower lumbar spine. The patient also complains of foot pain and plain films reveal evidence of a retrocalcaneal bursitis with erosion of the calcaneus. Hand x-rays reveal small erosions asymmetrically in the distal IP joints in both hands. What is the most likely diagnosis?**

- A. Ankylosing spondylitis.
- B. Reactive arthritis.
- C. Psoriatic arthritis.
- D. Erosive OA.
- E. Adult Still's disease.

**52. C. Psoriatic arthritis.**

Ankylosing spondylitis causes a symmetrical sacroiliitis. The syndesmophytes associated with this are marginal and fine. It also typically progresses superiorly from the lumbar spine. Both reactive arthritis and psoriatic arthritis cause an asymmetric sacroiliitis and the syndesmophytes are usually centred on the thoracolumbar spine and are non-marginal and bulky. Retrocalcaneal bursitis and erosions, whilst more common in reactive arthritis, can occur in psoriatic arthritis, and reactive arthritis would uncommonly affect the hands. Also, with all other factors being equal, psoriatic arthritis is much more common than reactive arthritis, even without the skin manifestations, which are absent in up to 20% at presentation.

**69. A 30-year-old male presents with a history of painful heels after a fall from a height. Plain radiograph demonstrates calcaneal fractures. Which of the following statements regarding calcaneal fractures is true?**

- A. Extraarticular fractures represent 75% of all calcaneal fractures.
- B. Calcaneal fracture classification is based on fracture line location at the posterior facet.
- C. Bilateral fractures are present in 30% of cases.
- D. The flexor hallucis longus tendon passes inferior to the sustentaculum tali on the lateral aspect of the calcaneus.
- E. Normal Boehler's angle is less than 20°.

**69. B.** Calcaneal fracture classification is based on fracture location at the posterior facet.

Calcaneal fractures represent 60% of fractures involving the tarsal bones. Axial loading resulting from a fall from a height is the most common cause followed by motor vehicle accidents. Treatment is based on accurate evaluation and classification of calcaneal fractures using multidetector CT reformats.

Calcaneal fractures are classified into intra-articular and extra-articular based on the involvement of the posterior facet of the subtalar joint. Intra-articular fractures, accounting for 75% of all calcaneal fractures, are further classified into four types depending on the number of fracture lines and fragments. Extra-articular fractures are classified into three types depending on whether the fracture involves the anterior, middle, or posterior aspect of calcaneus.

Bilateral fractures are seen in less than 10% of cases. Approximately 10% of calcaneal fractures are associated with compression injuries of the spine, commonly at the thoracolumbar junction.

Boehler's angle is formed by the intersection of (a) a line from the highest point of the posterior calcaneal tuberosity to the highest point of the posterior facet and (b) a line from the latter point to the highest of the anterior process. Normal Boehler's angle is 20–40°. An angle less than 20° indicates collapse of the posterior facet.

The sustentaculum tali is an eminence on the medial aspect of the calcaneus bearing the middle facet of subtalar joint.



**71. A patient is being assessed for a possible congenital foot deformity. Both AP and lateral weight-bearing views of the hind and fore foot have been taken. You are lucky to have an experienced radiographer working with you and she has carried out the standard measurements in assessing for foot deformities. The tibiocalcaneal angle measures  $60^\circ$  on the lateral foot image. On the AP hindfoot image, the talocalcaneal angle measures  $30^\circ$ . On the lateral foot image the metatarsals are superimposed, with the fifth metatarsal being in the most plantar position. What sort of deformity does this patient have?**

- A. None.
- B. Clubfoot.
- C. Rocker bottom foot.
- D. Flexible flat foot deformity.
- E. Pes cavus.

**71.A. None.**

This is a complicated question, but one that is frequently posed to musculoskeletal radiologists. A full description is beyond the remit of this section and the reader is referred to the excellent synopsis referenced below. Basically the foot is divided into the hind foot and fore foot when assessing for congenital abnormalities. The tibio-calcaneal angle (angle made by a line drawn along the length of both bones) should be between  $60^\circ$  and  $90^\circ$ . Less than this is due to abnormal dorsiflexion (e.g. as seen with congenital vertical talus, or rocker bottom foot) and more is due to equinus deformity. Secondly, degree of hindfoot varus or valgus is assessed. The talo-calcaneal angle (on an frontal hindfoot x-ray this is the angle between the lines drawn along the length of each bone) should be between  $15^\circ$  and  $40^\circ$ ; less is varus deformity and more is valgus. On the lateral view, the fore foot can be roughly assessed with two observations. Normally the metatarsals overlap. However, if the first metatarsal is the most plantar, then forefoot valgus is present (as the foot is too flat). If the metatarsals are not superimposed, then varus is present. The final step is to remember the features of the common conditions. These are clubfoot (hindfoot equinus and varus), pes planovalgus (hind foot and fore foot valgus, not equinus), and pes cavus (hindfoot valgus).

**22 With regards to the Ottawa rules for plain radiographs of the foot and ankle, which of the following is incorrect?**

- (a) An ankle X-ray is indicated if the patient cannot weight bear at the time of injury
- (b) An ankle X-ray is indicated if there is pain in the malleolar zone and bony tenderness over the base of the 5<sup>th</sup> metatarsal
- (c) A foot X-ray is indicated if there is pain in the midfoot zone and bony tenderness over the navicular
- (d) An ankle X-ray is indicated if the patient cannot weight bear in the department
- (e) An ankle X-ray is indicated if there is pain in the malleolar zone and bony tenderness over the posterior edge of the lateral malleolus

**22 (b)**

A foot x-ray is indicated with bony tenderness over the base of the 5<sup>th</sup> metatarsal (and midfoot pain).

**27 Axial MR imaging of the ankle is performed. You are asked to review a single image at the level of the tibio-talar joint. You note a tendon which is swollen and contains unusually high signal, located immediately posterior to the tendon of tibialis posterior.**

**What is the likely diagnosis?**

- (a) Tendonitis of extensor hallucis longus
- (b) Tendonitis of extensor digitorum longus
- (c) Tendonitis of flexor hallucis longus
- (d) Tendonitis of flexor digitorum longus
- (e) Tendonitis of tibialis anterior

**27 (d)**

The flexor tendons occur in the order (from anterior to posterior): tibialis posterior, flexor digitorum longus, flexor hallucis longus – the mnemonic 'Tom, Dick, and Harry' aids memory.

**29 A man suffers a supination-abduction ankle injury. Plain films reveal an oblique fibular fracture through the tibiofibular syndesmosis.**

**Which Weber category does this represent?**

- (a) A
- (b) B
- (c) C
- (d) D
- (e) E



**29 (b)**

The Weber classification is based on the location of the distal fibular fracture relative to the tibiotalar joint. Type A is a transverse fracture distal to the ankle joint; type B is an oblique fracture at the level of the joint; type C is a fibular fracture proximal to the level of the joint. There is no type D or E.

- 34 A patient presents with foot and ankle tenderness after a sports injury. Plain radiographs of the ankle and foot are taken.

Which of the following is an abnormal finding?

- (a) Bohler's angle is 31 degrees *30-40*
- (b) On an AP view of the midfoot, the medial margin of the second metatarsal aligns with the medial margin of the intermediate cuneiform
- (c) On an AP view of the midfoot, the medial margin of the third metatarsal aligns with the medial margin of the lateral cuneiform
- (d) The width of the space between the distal tibia and fibula at a point 1 cm from the articular surface is 8 mm *≤ 6 mm*
- (e) On the AP view of the midfoot, there is a lucent line through the base of the 5th metatarsal which runs parallel to the metatarsal shaft

34 (d)

The width of the space between the distal tibia and fibula at a point 1 cm from the articular surface should be  $\leq 6$  mm. Bohler's angle is normally 30–40 degrees. In contradistinction to a fracture, the long axis of an unfused apophysis of the base of the 5th metatarsal runs parallel to the metatarsal shaft. On an AP view of the midfoot, the medial margin of the second metatarsal should align with the medial margin of the intermediate cuneiform. On an AP view of the midfoot, the medial margin of the third metatarsal aligns with the medial margin of the lateral cuneiform.

- 47 A 40 year old man presents with heel pain. Lateral radiograph of the foot reveals a well defined 3 cm lesion located between the anterior and middle thirds of the calcaneus. The lesion is radiolucent with a thin rim of sclerosis and central calcification.**

**What is the likely diagnosis?**

- (a) Desmoplastic fibroma
- (b) Giant cell tumour
- (c) Intraosseous lipoma
- (d) Osteoid osteoma
- (e) Unicameral bone cyst

**47 (c)**

Intraosseous lipomas are rare bone tumours; they are often asymptomatic and present incidental, but can be associated with pain. The commonest locations are within the proximal femur (Ward's triangle) and in the area of the calcaneus described. In these areas there is a relative paucity of trabecular bone and it is thought that this leads to an 'overshoot' phenomenon during the transition of haematopoietic to fatty marrow, with the resultant formation of the lipoma. Central or ring calcification in a lucent lesion in this location of the calcaneus is said to be pathognomonic of an intraosseous lipoma and allows its distinction from a UBC. If clinical doubt persists MR imaging can be used for further clarification and to confirm the presence of fat.

- 28 A patient has lateral ankle pain and a feeling of hindfoot instability. MR imaging reveals a torn lateral collateral ligament and obliteration of the normal fat between the talus and calcaneus; no ligaments are visualised in this space.**

**What is the most likely diagnosis?**

- (a) Fibrous tarsal coalition
- (b) Sinus tarsi syndrome
- (c) Longitudinal split tears of peroneus brevis
- (d) Lateral gutter syndrome
- (e) Osteomyelitis



**28 (b)**

The sinus tarsi is the space between the talus and calcaneum that contains several ligaments conferring some hindfoot stability. In sinus tarsi syndrome there is obliteration of the normal fat and disruption of at least one of the ligaments.

**40 A 36 year old active male patient presents with medial foot pain. AP foot x-ray shows a triangular bone fragment projected adjacent to the medial aspect of the navicular bone, which is itself irregular in outline with a sclerotic rim. Subsequent MR imaging shows bone marrow oedema within the medial navicular and the adjacent bone seen on x-ray; additionally there is high signal within the posterior tibial tendon on T2W imaging.**

**What is the likely underlying diagnosis?**

- (a) Cornuate navicular bone
- (b) Avulsion fracture of the medial navicular tuberosity
- (c) Stress fracture of the navicular
- (d) Os tibiale externum
- (e) Type 2 accessory navicular bone

**40 (e)**

3 types of accessory navicular bones have been described; they have a collective incidence of 4–21%. Type 1 (os tibiale externum) is a small, round sesamoid bone within the posterior tibial tendon. Type 2 is a triangular ossification centre adjacent to the navicular tuberosity and connected by a synchondrosis (which is often irregular). Type 3 (cornuate navicular bone) describes an enlarged medial horn of the navicular. Types 2 and 3 are associated with PTT tears, but can independently cause pain also. Type 2 accounts for 70% of accessory navicular bones and are the dominant type in symptomatic patients. In types 2 or 3, the PTT inserts onto the accessory ossicle, leading to a more proximal insertion, reducing the leverage of the malleolus on the PTT and increasing the stress on the tendon.



- 65 An active 48 year old woman presents with pain and paresthesia between the 3rd and 4th metatarsals, which radiates to the toes. On examination, direct pressure between the metatarsal heads replicates the pain. On axial compression of the forefoot a 'click' is heard. MR shows a well demarcated 'teardrop-shaped' mass arising between the 3rd and the 4th metatarsal heads. The lesion is isointense to muscle on T1W and hypointense to fat on T2W, and enhances on T1W following *i.v.* gadolinium.

**What is the likely diagnosis?**

- (a) Freiberg's disease
- (b) Morton's neuroma
- (c) Rheumatoid nodule
- (d) Schwannoma
- (e) Tendon sheath ganglion

**65 (b)**

Morton's neuroma is actually a peri-neural fibrosis entrapping a plantar digital nerve. It is most commonly found in the 3rd/ 4th intermetatarsal space. The fibrous nature of the lesion accounts for the described MR findings. The 'click' which can be heard or palpated on examination is known as 'Mulder's' sign.

- 15) On plain radiographs of the hands in a middle-aged male patient complaining of bilateral joint pain and swelling, which single feature is most likely to support a diagnosis of psoriatic arthritis over rheumatoid arthritis?
- a. new bone formation
  - b. joint space loss
  - c. periarticular osteoporosis
  - d. periarticular erosions
  - e. soft-tissue swelling

15) a. \*\*

New bone formation is the hallmark finding of psoriatic arthritis and is not seen in rheumatoid arthritis. Conversely, periarticular osteoporosis is seen in rheumatoid but is not a feature of psoriatic arthritis. Both conditions may cause soft-tissue swelling (typically a sausage digit in psoriatic arthritis), joint space loss and erosions, which are marginal in psoriatic and marginal and/or central in rheumatoid arthritis. Another distinguishing factor is the distribution of involved joints in the hands, which is typically, but not always, interphalangeal in psoriatic and metacarpophalangeal in rheumatoid arthritis.

- 22) A 32-year-old woman with a long history of right knee pain undergoes radiography for atraumatic swelling of the joint and is found to have an effusion and soft-tissue swelling but no other findings. MRI shows a large anterolateral lobular intra-articular mass of low signal on T1W and T2W images, and a blooming artefact is seen on gradient echo sequences. What is the most likely condition?
- a. malignant fibrous histiocytoma
  - b. pigmented villonodular synovitis
  - c. synovial osteochondromatosis
  - d. Baker's cyst
  - e. intra-articular haematoma

22) b. \*\*\*

Pigmented villonodular synovitis is a benign proliferative disorder of the synovium that has a propensity for young to middle-aged adults and typically has a long history. On plain radiographs, joint space and bone mineralization are typically preserved until late in the disease, but soft-tissue swelling or effusion may be apparent early on. Haemorrhage is relatively common and can result in haemarthrosis and blooming artefact seen on gradient echo MRI sequences. Malignant fibrous histiocytoma is the most common soft-tissue sarcoma after age 50. Synovial osteochondromatosis is more common in men and is characterized by proliferation of the synovium with formation of cartilaginous nodules (that often calcify), but does not show haemorrhage. Baker's cyst has synovial fluid characteristics on MRI and is located posterior to the joint.

32) A young man complains of early morning back pain and stiffness, and undergoes plain radiographs followed by MRI of the whole spine. Which single feature is most likely to suggest a diagnosis of psoriatic arthritis over ankylosing spondylitis?

- a. syndesmophytes
- b. parasyndesmophytes
- c. asymmetrical sacroiliitis
- d. ankylosis
- e. patchy bone marrow oedema



32) b.

Seronegative spondyloarthritis is an umbrella term for inflammatory joint or spinal conditions that are not associated with rheumatoid factor or rheumatoid nodules. There are five described subgroups: ankylosing spondylitis, psoriatic arthritis, arthritis associated with inflammatory bowel disease, reactive arthritis (e.g. Reiter's syndrome) and an undifferentiated subgroup. The subgroups may overlap both clinically and radiologically, and the diagnosis is more easily made on the basis of clinical history and examination. Imaging plays a limited role in differentiation, particularly early in the disease when there can be considerable overlap of appearances. The main exception is the identification of parasyndesmophytes, which are seen almost exclusively

in psoriatic arthropathy. In addition, bone marrow oedema can involve the entire vertebral body in psoriatic arthritis, which may be a further useful distinguishing feature. Undifferentiated spondyloarthritis is diagnosed when there is no clinical or radiological evidence of sacroiliitis. All types may eventually progress to ankylosis.

46) On plain radiographs of the hands, hyperflexion of the proximal interphalangeal joint of the index finger, with hyperextension of the distal interphalangeal joint of the same finger, describes which deformity?

a. swan-neck

b. Boutonnière

c. mallet finger

d. baseball finger

e. Z-deformity

The same as boutonnière of thumb  
all from flexion  
at the proximal  
interphalangeal  
joint (flexion)

46) b. \*\*

The Boutonnière deformity is commonly caused by injury or inflammatory conditions such as rheumatoid arthritis, and more commonly affects the index than middle fingers. It consists of four stages. Stages 1 and 2 are mild and moderate, passively correctable extension lag, whereas stages 3 and 4 are mild and advanced flexion contractures. The proximal flexion deformity is due to disruption of the central slip of the extensor tendon, with the proximal phalanx herniating through the defect and the lateral slips lying on either side. The position of the proximal phalanx stretches the lateral slips and pulls the distal phalanx into extension. Swan-neck deformity has similar causes but the opposite configuration, with extension at the proximal interphalangeal joint and flexion distally. Mallet (or baseball) fingers have a passively correctable flexion deformity of the distal interphalangeal joint caused by avulsion of the extensor digitorum tendon by a hyperflexion injury. Z-deformity is the name given to a Boutonnière-type deformity seen in the thumb.

58) An elderly female patient has plain radiographs performed in an outpatient clinic for bilateral painful, stiff hips, which demonstrate joint space narrowing. Which additional feature is more likely to support a diagnosis of rheumatoid arthritis rather than osteoarthritis?

- a. eccentric joint space loss
- b. soft-tissue swelling
- c. subchondral sclerosis
- d. subchondral cysts
- e. protrusio acetabuli



58) e. \*\*\*

Even or eccentric joint space reduction representing cartilage loss is seen in both types of arthritis and not a distinguishing diagnostic feature. Although osteoarthritis is said to be classically eccentric, this is difficult to assess accurately on many hip radiographs, as they are not routinely taken in the upright, weight-bearing position. Subchondral sclerosis and cysts are typically associated with degenerative osteoarthritis. Although soft-tissue swelling is a feature of rheumatoid arthritis, the depth of the hip joint and the copious surrounding soft tissues mean that any synovial swelling is unlikely to be appreciated clinically or radiologically. Subtle osteophytes (in osteoarthritis) or erosive change/osteoporosis (in rheumatoid arthritis) can distinguish between the two entities. An inflammatory cause should be considered in young adults with hip pain and, if protrusio or other abnormalities are found, the sacroiliac joints should be examined.

2. A 35 year old man presents with increasing stiffness in his knee and soft tissue swelling around the joint. Plain films show multiple areas of irregular cyst-like radiolucencies in the distal femur. There are no areas of abnormal calcification and there is no evidence of periarticular osteoporosis. MR shows a low signal joint effusion on both T1 and T2 sequences. The most likely diagnosis is:
- a. Synovial osteochondromatosis
  - b. Pigmented villonodular synovitis
  - c. Osteoarthritis
  - d. Reiter's syndrome
  - e. Osteomyelitis

2. b. Pigmented villonodular synovitis

Pigmented villonodular synovitis is a relatively rare condition which usually presents in the third or fourth decade. It is a monoarticular, painful disease which causes a decreased range of movement at the affected joint. It is most common at the knee (80%) followed by the hip, ankle, shoulder and elbow. Haemorrhagic 'chocolate' effusion is characteristic. Low signal effusion on all sequences at MR is characteristic. There is no calcification or osteoporosis, and joint space narrowing is a late feature.



In a 21 year old man with symptoms of chronic back pain, pain in his feet, particularly the great toe and metatarsophalangeal joints, and bilateral sacroiliitis on plain films, the most likely diagnosis is:

- a. Ankylosing spondylitis
- b. Gout
- c. Inflammatory bowel disease-related arthropathy
- d. Reiter's syndrome
- e. Psoriatic arthritis

**7. d. Reiter's syndrome**

Reiter's syndrome is the association of urethritis, conjunctivitis and mucocutaneous lesions. Sacroiliitis is usually bilateral but often persists asymmetrically. There is an association with the HLA B27 antigen. Reiter's has a predilection for the great toe and metatarsophalangeal joints.

21. A routine pre-operative chest X-ray in a 62 year old woman shows bilateral erosion of the distal clavicles. Which one of the following conditions might be responsible?
- a. Hypoparathyroidism
  - b. Rheumatoid arthritis
  - c. Langerhans' cell histiocytosis
  - d. Ankylosing spondylitis
  - e. Sarcoidosis

**21. b. Rheumatoid arthritis**

Myeloma, hyperparathyroidism, metastases, cleidocranial dysplasia and Gorlin basal cell nevus syndrome all cause absence of the outer end of the clavicle. Destruction of the medial end of the clavicle is caused by metastases, infection, lymphoma, eosinophilic granuloma, rheumatoid arthritis and sarcoma.

40. A 57 year old man with increasing pain and stiffness in his hands and feet and worsening back pain presents to his GP. Plain films of his hands show sclerosis of the terminal phalanges and several 'pencil-in-cup' erosions. There is destruction of the interphalangeal joint of his right great toe with exuberant periosteal reaction. There is also erosion of the posterior margin of the calcaneus. The most likely diagnosis is:
- a. Reiter's syndrome
  - b. Ankylosing spondylitis
  - c. Rheumatoid arthritis
  - d. Psoriatic arthritis
  - e. Osteoarthritis

**40. d. Psoriatic arthritis**

This is usually HLA B27 positive and is associated with skin and nail changes in the majority of cases. The hands are often described as having sausage digits, and erosions with ill-defined margins are characteristic. Sacroiliitis is often present and most often bilateral. Within the axial skeleton, there is often large bulky vertically orientated soft-tissue ossification giving a 'floating' osteophyte appearance.

- 17 A 37-year-old female with a long history of right knee pain is eventually diagnosed with pigmented villonodular synovitis (PVNS). What are the most likely findings on imaging?
- a Marked joint space narrowing
  - b High signal of abnormal synovium on all MRI sequences
  - c Expansion of prefemoral fat pad
  - d Sclerotic deposits in articular surfaces
  - e Joint effusion

**17 Answer E: Joint effusion**

The knee is the most common location for PVNS. The soft tissues appear dense due to haemosiderin deposits and there are multiple sites of cyst-like radiolucent defects due to bone invasion. There is not usually any evidence of calcification, osteoporosis and joint space narrowing until later on. There is low signal on all sequences due to the presence of haemosiderin. Other features include: knee joint effusion on plain films, scalloping of pre-femoral fat pad, soft-tissue mass around joint, no joint space narrowing.

- 18** A 46-year-old coal miner with recently diagnosed rheumatoid arthritis was investigated for respiratory symptoms and found to have multiple rapidly developing lung nodules throughout the lungs with a upper and peripheral predominance. What complication is likely to have developed?
- a Gaucher's disease
  - b Caplan's syndrome
  - c Felty's syndrome
  - d Acute interstitial pneumonia (AIP)
  - e Panner's disease

**18** Answer B: Caplan's syndrome

Caplan's syndrome is a hyperimmune reactivity to silica inhalation with rapidly developing pulmonary nodules. Felty's syndrome is RA plus splenomegaly and osteopenia. Panner's disease is osteonecrosis of the capitellum.

- 20** A 56-year-old female patient with stiffness and pain was referred for a radiograph of both hands. What features would favour a diagnosis of psoriatic arthritis over one of rheumatoid arthritis?
- a Symmetrical distribution
  - b Predominant involvement of metacarpophalangeal joints
  - c Periarticular osteopenia
  - d Periosteal reaction
  - e Marginal erosions

**20** Answer D: Periosteal reaction

Periosteal reaction is a frequent finding in psoriatic arthritis. Twenty per cent of patients with psoriasis develop psoriatic arthropathy which is classified into true psoriatic, resembling rheumatoid and concomitant rheumatoid and psoriatic type. The onset of arthritis often precedes the skin rash. The distribution is variable and asymmetrical, affecting hand and foot and axial skeleton. Features include 'pencil in cup' deformity, ivory phalanx, squaring of vertebrae and atlantoaxial subluxation.

- 10 A 50-year-old man is known to have haemochromatosis and presents with pain in his hands. What distribution of involvement would be typical?
- a Interphalangeal joint of thumb
  - b Proximal interphalangeal joints of all fingers
  - c Distal interphalangeal joints of middle and ring fingers
  - d Metacarpophalangeal joints of index and middle fingers
  - e Metacarpophalangeal joints of ring and little fingers

10 Answer E: Metacarpophalangeal joints of index and middle fingers

This classical distribution is distinctive although not every case will show the classical findings.

- 16 A 67-year-old woman with known rheumatoid arthritis presented with right shoulder pain and a radiograph was performed. There was no history of trauma and secondary osteoarthritis was not thought to be a dominant feature. What features would be typical?
- a Subchondral lucency
  - b Osteophytosis of the glenoid
  - c Increased joint space
  - d Widened glenohumeral joint space
  - e Tapered margin of distal clavicle

16 Answer E: Tapered margin of distal clavicle

Rheumatoid arthritis (RA) is a connective disease with associated immune complex deposition. There are early and late signs of the disease. RA affects hand and wrist, cervical spine, ribs, shoulder, hips, knee and feet. The main features are: erosions, loss of joint space, subchondral sclerosis. Other features include: osteoporosis, scalloped erosion on undersurface of clavicle, tapered margin of distal clavicle.

- 18 A 50-year-old man presented with foot pain and radiographs showed involvement of a number of joints with generally non-specific findings. What underlying diagnosis would the presence of periostitis favour?
- a Gout
  - b Pseudogout
  - c Psoriatic arthritis
  - d Haemophilia
  - e Rheumatoid arthritis

18 Answer C: Psoriatic arthritis

Other causes are juvenile rheumatoid arthritis, infectious arthritis and Reiter's syndrome.

- 27 A 55-year-old lady with rheumatoid arthritis presented to the Emergency Department with sudden onset pain and swelling on the medial side of her left foot. Clinical examination revealed marked weakness of plantar flexion and inversion on the left, but normal power on the right. What tendon is most likely to have been injured?
- a Extensor digitorum
  - b Peroneus tertius
  - c Tibialis anterior
  - d Flexor hallucis longus
  - e Tibialis posterior

27 Answer E: Tibialis posterior

Spontaneous tibialis posterior rupture tends to occur in those with underlying pathology, especially rheumatoid arthritis. The typical presentation is in a woman of 40–60 years and the presenting signs and symptoms are pain, difficulty walking, and swelling along the medial malleolus and the arch of the foot. Traumatic rupture is more common in a younger age group and is not normally secondary to another pathology.

- 1 A 20-year-old Caucasian male presented to his GP with backache. He was known to be HLA-B27 positive. Imaging of the sacroiliac (SI) joints showed bilateral symmetrical features, extensive sclerosis and erosions. Which of the following is the most likely diagnosis?
- a Osteoarthritis
  - b Ankylosing spondylitis
  - c Osteitis condensans
  - d Reiter syndrome
  - e Infection

1 Answer B: Ankylosing spondylitis (AS)

This is the most likely diagnosis because it affects younger males, with extensive sclerosis and often with erosions. AS can cause both SI joint widening and fusion. Diseases that can cause bilateral symmetrical sacroiliitis include: AS, enteropathic arthropathy, late rheumatoid arthritis, deposition arthropathy and osteitis condensans ilii.

- 8 A 74-year-old man with gout presented with recurrent foot pain and an X-ray of both his feet was taken. What is a typical feature of a joint affected by gout?
- a Joint space preserved until late in disease
  - b No joint effusion
  - c Periarticular demineralisation
  - d Erosions with thick sclerotic margins
  - e Chondrocalcinosis in the majority of cases



**8** Answer A: Joint space preserved until late in disease

Gout is a disorder of purine metabolism, typically in middle-aged males, with four main parts: hyperuricaemia, deposition of positively birefringent crystals in synovial fluid, deposits of sodium urate in periarticular soft tissues, recurrent episodes of arthritis. It can be primary or secondary. The gouty tophus is pathognomonic histologically. The stages are: asymptomatic hyperuricaemia, acute gouty arthritis, chronic tophaceous gout and gouty nephropathy. Forty-five per cent of affected patients have radiological features, but these features are not seen until 6–12 years after the initial attack. Common locations are: joints, particularly hands and feet, bones, external ear. In the joint, effusion is the earliest sign, with periarticular swelling and preservation of joint space until late in the disease. The attacks are

short so there is no periarticular demineralisation. Eccentric erosions are also seen, particularly at the metacarpal bases. Chondrocalcinosis is only seen in 5%.

- 10** A 50-year-old man is known to have haemochromatosis and presents with pain in his hands. What finding would be typical?
- a Osteosclerosis
  - b Geodes
  - c Chondrocalcinosis
  - d Asymmetric joint space narrowing
  - e Narrowing of metacarpal heads

**10** Answer C: Chondrocalcinosis

Haemochromatosis can be primary (inherited) or secondary (excessive iron absorption in anaemias, myelofibrosis, exogenous administration). Symptoms include: cirrhosis, congestive heart failure, arthritic symptoms. Skeletal features include: generalised osteoporosis, small subchondral cyst-like lesions in the metacarpal heads, arthropathy in 50%, uniform joint space narrowing, enlargement of metacarpal heads, osteophyte formation and chondrocalcinosis in 60%. The differential diagnosis includes: pseudogout, psoriatic arthritis, OA, RA, gout.

- 13 A 60-year-old patient with a long history of diabetes peripheral neuropathy presented with ankle deformity. What feature would be in keeping with a Charcot joint?
- a Juxta-articular osteoporosis
  - b Loose bodies
  - c Severe pain
  - d Blunted shape of metatarsal heads
  - e Widened joint space

13 Answer B: Loose bodies

The patient usually experiences a warm, painless joint, usually with a joint effusion, narrowed joint space, calcification in the soft tissues, and fragmentation of subchondral bone. Juxta-articular osteoporosis is not usually seen unless the joint is infected. Dense subchondral bone (sclerosis), Degeneration, Destruction of articular cortex, Deformity ('pencil points' of metatarsal heads), Debris and Dislocation is one way of helping remember the findings.

- 14 A 14-year-old boy presents to his GP with joint pain, fever, rash and lymphadenopathy. Radiographs showed: rectangular phalanges in the hands and ribbon ribs, pleural effusion and pericardial effusion. What is the most likely diagnosis?
- a Osteoarthritis
  - b Still disease
  - c Reiter's disease
  - d Felty's syndrome
  - e Psoriatic arthritis

14 Answer B: Still disease

This is essentially rheumatoid arthritis in patients younger than 16 and is more common in females. Still disease is systemic and may be polyarticular or pauci-articular. Typical findings include 'balloon epiphyses', 'gracile bones', rectangular phalanges and ribbon ribs. Large joints tend to be involved first. Other differences from rheumatoid arthritis are a late onset of bony changes, more ankylosis and widening of the metaphyses.

- 66 A 40-year-old woman presented with a long history of a painful joint and was found to have pigmented villonodular synovitis (PVNS). Which joint was most likely to have been affected?
- a Ankle
  - b Elbow
  - c Hip
  - d Knee
  - e Shoulder

66 Answer D: Knee

Eighty per cent of cases occur in the knee and are usually monoarticular.

2. **A 28-year-old male presents with soft tissue swelling, pain, and reduction of motion in the small joints of his hands. Plain films of the hands show erosions at the metacarpophalangeal (MCP) joints and distal interphalangeal joints with periosteal reaction and enthesophytes. What is the most likely diagnosis?**
- A. Psoriatic arthropathy.
  - B. RA.
  - C. SLE.
  - D. Haemochromatosis.
  - E. Calcium pyrophosphate dihydrate crystal deposition disease.

**2. A. Psoriatic arthropathy.**

Bone involvement before skin changes is evident in up to 20% of cases. Nail pitting or discolouration is common and correlated with the severity of the arthropathy. Five distinct manifestations have been described: oligoarthritis, polyarthritis (predominately distal IP joints), symmetric type (resembling RA), arthritis mutilans, and spondyloarthropathy. The characteristic distribution involves the small joints of the hands and feet, with or without spondyloarthropathy. Involvement in the hands tends to include distal IP as well as MCP or PIP joints, with early tuft

resorption and distal IP erosive disease. The erosions become so severe that a 'pencil-in-cup' deformity and telescoping of the joint may occur. Bone density can be normal and the joint distribution is asymmetric. Similarly, sacroiliitis is asymmetric, unlike ankylosing spondylitis and syndesmophytes, which are non-marginal and asymmetric; in ankylosing spondylitis they are marginal and asymmetric. The spondyloarthropathy of psoriatic arthropathy is indistinguishable from that of reactive arthritis, the clinical scenario (rash vs uveitis/urethritis) providing the diagnosis.

The arthropathies of CPPD disease and haemochromatosis are essentially identical radiographically. Chondrocalcinosis is commonly seen in the wrist (triangular fibrocartilage) and knee (menisci). The joints most affected are the knee, wrist and second and third MCPs of the hand: the IP joints tend to be spared. Early disease shows erosive change. More advanced disease demonstrates sclerosis, osteochondral fragments, and osteophytes. Subchondral cysts are common and large. RA is rarely found in the distal IP joints and periosteal reaction is not a feature. SLE is usually non-erosive and affects the MCP joints.

- 4. A 63-year-old female is being worked up for a left total hip replacement. She has a history of RA. As part of the routine pre-operative assessment in your hospital a cervical spine radiograph is requested. This demonstrates that there is widening of the pre-dental space, with the anterior arch of C1 located anterior to the lower part of the body of C2. The dens is not clearly visible. This appearance is constant on the flexion view. The patient is asymptomatic. What do you think these findings represent?**
- A. Degenerative change.
  - B. Pannus erosion of dens.
  - C. Atlanto-axial subluxation.
  - D. Erosion of the occipital condyles.
  - E. Atlanto-axial impaction.

**4. E. Atlanto-axial impaction.**

This is a more severe form of atlanto-axial subluxation where the C1-2 facets collapse and there is invagination of the dens of C2 into the foramen magnum. As such, the dens is not visible on the lateral radiograph. The key feature, apart from widening of the pre-dental space (which can also be caused by pannus eroding the dens or more commonly atlanto-axial subluxation), is that the anterior arch of C1 lies in front of the lower portion of C2, whereas it normally lies anterior to the dens.



**8. A 44-year-old female patient presents to the rheumatologists with a history of multiple painful joints for 2 years. She has synovitis clinically, confirmed on ultrasound, which involves the MCP joints bilaterally. PA and Norgaard views of the hands are requested and show small erosions in the distal radio-ulnar joint and the piso-triquetral joint, but no erosions at the MCP joints. There is widening of the scapholunate interval on the right side. There is ankylosis of the capitate to the hamate on the left. There is periarticular osteoporosis. Which of these features is atypical of RA?**

- A. Symmetrical disease.
- B. Synovitis on ultrasound but no erosions radiographically.
- C. Erosions noted in the radio-ulnar joint and radio-carpal joint preceding MCP erosions.
- D. Bony ankylosis of the carpal bones.
- E. Periarticular osteoporosis.

**8. D. Bony ankylosis of the carpal bones.**

Whilst fibrous ankylosis of the carpal and tarsal bones does occur, bony ankylosis is extremely rare in RA. It is, however, common in JRA. There are a number of unusual findings, which if present should indicate a diagnosis other than RA. Productive bone change (e.g. periostitis or enthesopathy) is extremely unusual. Osteophytes are also uncommon in the absence of advanced associated osteoarthritic change. The exception to this is the distal ulna, a feature known as ulnar capping. The other features are all typical of RA.

**27. You are reporting an MRI knee on a patient with moderately severe osteoarthritis (OA), as diagnosed on plain film radiography. The patient describes significant knee pain. Which of the following statements best describes the relationship between symptoms, plain film findings, and MRI findings?**

- A. The MRI findings correlate well with the severity of findings on plain film radiography.
- B. MRI findings correlate well with the patient's symptoms.
- C. Plain film findings correlate well with the patient's symptoms, unlike MRI.
- D. Plain film and MRI both correlate well with the severity of the patient's symptoms.
- E. Symptoms, plain film findings, and MRI findings do not have a significant association with each other.

**27. A. The MRI findings correlate well with the severity of findings on plain film radiography.**

MRI has been shown to correlate well with the severity of OA as depicted on plain film radiography. Neither MRI nor plain film appearances are significantly associated with the patient's symptoms.

**32. You are discussing OA with a rheumatologist. He/she is curious to know what radiological findings seen in early disease are associated with progressive, as opposed to stable, arthritis. All of these are associated with OA, but which is least likely to indicate progressive disease?**

- A. Increased uptake on isotope bone scan.
- B. Grade 1 osteophytosis in the knee.
- C. Osteochondral defect.
- D. A focal area of high signal on T2WI and STIR in the subchondral bone.
- E. A serpiginous subchondral line that is low signal on T2WI and T1WI, with an adjacent T2WI high signal line.

**32. B.** Grade 1 osteophytosis in the knee.

While the Kellgren and Lawrence grading of OA is the most widely used scale for grading OA on plain films, early osteophyte formation is not definitively 'arthritic' change. Studies have shown that patients with this type of early change infrequently progress to developing more severe disease. Recent research in OA is focused on the impact of the subchondral bone on the disease, rather than hyaline cartilage. This is evidenced by increased uptake on bone scan being closely linked to progressive OA, even in patients with relatively normal joints on plain film. The foci of high signal on T2WI and STIR are bone marrow lesions that if persistent can indicate pathology in the subchondral bone, which can lead to arthritic change. The serpiginous line describes the classical finding of avascular necrosis. Both this and osteochondral defects lead to progressive OA change.



**37. A 55-year-old female presents to the rheumatologists with a history of episodic swollen red joints over the previous 2 years. She also complains of left hip pain. The patient's rheumatoid factor is not known at the time of requesting the radiographs. There is no other past medical history. The rheumatologists have requested bilateral hand and pelvis x-rays. The hand x-rays show bilateral asymmetric disease affecting the distal and proximal interphalangeal (IP) joints. In the affected distal IP joints there are central erosions, adjacent sclerosis, and marginal osteophytes. The first carpometacarpal joint in the left hand shows loss of joint space with osteophyte formation. The scaphoid-trapezium joint in the right hand also shows loss of joint space and adjacent sclerosis. In the left hip there is non-uniform loss of joint space, with associated subchondral cyst formation. What is the main differential?**

- A. RA.
- B. Psoriatic arthritis.
- C. Erosive OA.
- D. Calcium pyrophosphate deposition (CPPD) arthropathy.
- E. Ankylosing spondylitis.

**37. C. Erosive OA.**

If the presence of erosions is ignored the pattern of disease is typical of OA. Erosive, or inflammatory, OA shows typical OA distribution, but with central erosions in the affected joint spaces in the distal IP, and less commonly proximal IP, joints. These central erosions in combination with marginal osteophytes give the classical gull-wing appearance to affected joints. Whilst individual joint appearance can be identical to psoriatic arthropathy, which can precede the development of the skin disease, the overall pattern is atypical, making it less likely. Also, while the distribution of CPPD arthropathy is often identical to OA, it would not cause erosions, and would usually be associated with chondrocalcinosis.

- 39. A 30-year-old man presents with backache and morning stiffness. Examination reveals loss of spinal movement, uveitis, and upper zone end inspiratory fine crepitations on auscultation. Which of the following statements is most correct in relation to the radiological features of the underlying condition?**
- A. Romanus lesions (anterior or posterior spondylitis) are a late feature.
  - B. Syndesmophytes are better depicted on MRI than plain film.
  - C. Ankylosis involves the vertebral edges or centre.
  - / D. Sacroiliac joint widening is not a feature.
  - E. Enthesitis appears as low signal within the ligaments on STIR imaging.

**39. C.** Ankylosis involves the vertebral edges or centre.

The question refers to ankylosing spondylitis. Ankylosis involves the vertebral edges or centre, with bony extension through the disc. The former is thought to be secondary to a Romanus lesion, the latter an Andersson lesion. Romanus lesions are irregularities and erosions involving the anterior and posterior edges of the vertebral endplates and are the earliest changes of spondylitis depicted on conventional radiographs. On MRI an Andersson lesion is depicted as disc-related signal-intensity abnormalities of one or both vertebral halves of a disc/vertebral unit. They are often hemispherically shaped. MRI is better than conventional radiography at depicting Romanus lesions, Andersson lesions (spondylodiscitis), and most other abnormalities, although ankylosis is equally well detected by both modalities.

Syndesmophytes are difficult to detect on MRI. Plain radiography is superior in this respect because of its superior spatial resolution; syndesmophytes are seen as bony outgrowths of the anterior vertebral edges. They occur in 15% of the vertebrae of patients. Apical pulmonary fibrosis affects 1% of patients. Sacroiliac (SI) joint erosion and widening is an early feature, and this may initially be more prominent on the iliac side of the joint, as the cartilage on that side is normally thinner. Later in the disease, sclerosis and ankylosis occur and the SI joints become symmetrically fused. Enthesitis is most prominently seen when the interspinous ligaments, those that extend between the spinous processes, and the supraspinal ligaments are affected. Ligamentous involvement is characterized by an increased signal intensity on either STIR images or contrast-enhanced T1WI fat saturated sequences. It may be associated with osteitis of adjacent bone marrow in the spinous processes. Arthritis of the synovial joints (e.g. facet joints) and insufficiency fractures (often spontaneous or after minor trauma) are also features of the seronegative spondylarthritides.



**42. An 81-year-old male diabetic is referred from the endocrinology team for an MRI of foot. This patient was seeing a podiatrist, who became concerned that the foot had become increasingly deformed and was acutely red and swollen around the tarso-metatarsal joints. The patient is asymptomatic as he has peripheral neuropathy. The clinical query is whether this patient has osteomyelitis/septic arthritis in this region, or neuropathic arthropathy. Which of these MRI features would be more typically associated with osteomyelitis than acute neuropathic arthropathy?**

- A. Focal involvement.
- B. Predominant midfoot involvement.
- C. Associated bony debris.
- D. High T2WI and STIR, low T1WI. Enhancement present.
- E. Bony changes are in a periarticular and subchondral location.

**42.A. Focal involvement.**

Whilst differentiating these conditions can be difficult and they frequently overlap, there are certain features that can be of value. Neuropathic arthropathy (NA) seldom affects a single bone/joint in the foot, and is most common in the midfoot region. As such a more focal abnormality, or abnormality affecting the metatarsal heads, or other points of pressure, should indicate osteomyelitis. Whilst high T2WI/STIR, low T1WI and enhancement are seen in osteomyelitis, it is also seen in acute NA and as such is not a good differentiating factor. The converse is not true, where low signal on T1WI and T2WI, typical of chronic NA, would make the presence of osteomyelitis unlikely.

**47. A patient presents to their GP with a complex history of acute episodes of severe tender inflamed joints, in particular around the knee. At present the patient has joint stiffness which is most pronounced in the evenings and mild joint pain. The patient has a past medical history of hypothyroidism. A plain film is requested which shows chondrocalcinosis and moderate degenerative change in the lateral tibiofemoral compartment and the patellofemoral compartment. Regarding CPPD disease, which of the following statements is the most appropriate?**

- A. The presence of chondrocalcinosis indicates a radiological diagnosis of pseudogout.
- B. Pseudogout syndrome is the most common means of presentation for this disease.
- C. Disproportionate involvement of the patellofemoral joint is the most frequently seen radiographic finding.
- D. The presence of crystals displaying positive birefringence at polarized light microscopy allows for the definitive diagnosis of pyrophosphate arthropathy.
- E. The presence of hypothyroidism is associated with the diagnosis.

**47. E.** The presence of hypothyroidism is associated with the diagnosis.

Disorders associated with CPPD are the four Hs: hyperparathyroidism, haemochromatosis, hypothyroidism, and hypomagnesaemia. Use of nomenclature in this disorder is confused. Pseudogout is the clinical presentation of an acutely inflamed joint due to calcium pyrophosphate crystal deposition, and as such is not a radiological diagnosis. Pseudogout syndrome is the dominant feature in only 10–20% of cases of CPPD. Another 10–20% of cases are asymptomatic, whilst most present with symptoms identical to OA, with occasional flares. Disproportionate involvement of the patellofemoral joint is a characteristic feature, but is only occasionally seen. Pyrophosphate arthropathy is a description of the pattern of disease present due to crystal deposition, and as such is not a diagnosis made by analysis of joint aspirate.

**52. A 24-year-old male patient is referred from the rheumatologists with a history of back pain and hip pain. Plain films are carried out. These show bilateral sacroiliitis with erosive change on the iliac side on the left, but sacral and iliac erosions on the right. The imaging of the spine reveals large non-marginal syndesmophytes in the thoracolumbar spine with a relatively normal lower lumbar spine. The patient also complains of foot pain and plain films reveal evidence of a retrocalcaneal bursitis with erosion of the calcaneus. Hand x-rays reveal small erosions asymmetrically in the distal IP joints in both hands. What is the most likely diagnosis?**

- A. Ankylosing spondylitis.
- B. Reactive arthritis.
- C. Psoriatic arthritis.
- D. Erosive OA.
- E. Adult Still's disease.

**52. C.** Psoriatic arthritis.

Ankylosing spondylitis causes a symmetrical sacroiliitis. The syndesmophytes associated with this are marginal and fine. It also typically progresses superiorly from the lumbar spine. Both reactive arthritis and psoriatic arthritis cause an asymmetric sacroiliitis and the syndesmophytes are usually centred on the thoracolumbar spine and are non-marginal and bulky. Retrocalcaneal bursitis and erosions, whilst more common in reactive arthritis, can occur in psoriatic arthritis, and reactive arthritis would uncommonly affect the hands. Also, with all other factors being equal, psoriatic arthritis is much more common than reactive arthritis, even without the skin manifestations, which are absent in up to 20% at presentation.



**75. A 35-year-old man presents with pain, swelling, and reduced movement of his knee. A plain film reveals a joint effusion, well-defined erosions with preservation of joint space, and normal bone mineralization. An MRI reveals, in addition, a mass in the region of the femoro-tibial joint space with low signal on T1WI and T2WI, and blooming artefact on GE imaging. What is the most likely diagnosis?**

- A. Synovial cell sarcoma.
- B. Regional migratory osteoporosis.
- C. Gout.
- D. Synovial chondromatosis.
- E. PVNS.

**75. E. PVNS.**

This is a monoarticular tumour-like proliferation of synovium that occurs in joints, bursae, and tendon sheaths. It may be focal or diffuse. It occurs most frequently in the knee (80% of cases), then the hip, ankle, shoulder, and elbow. The abnormal synovium is prone to haemorrhage, thus producing blooming artefact on GE sequences, secondary to haemosiderin deposition. In general the classic MRI appearance is variable low signal intensity on all sequences (T2WI signal being more variable due to fat, oedema, and blood products). Early changes involve a focal mass and joint effusion. Subsequently large erosions, synovial hypertrophy, and subchondral cysts may occur. Joint space is preserved until advanced disease is present and bone density is normal. After IV contrast at CT, PVNS shows variable enhancement, which can be striking. The differential diagnosis includes diseases causing recurrent haemarthroses, e.g. haemophilia and haemochromatosis (PVNS is monoarticular) as well as gout, amyloid, synovial chondromatosis, and tuberculosis.

Some 90% of synovial cell sarcomas do not originate from a joint. They are usually isointense to muscle on T1WI, with heterogeneous high-signal intensity on T2WI. Regional migratory osteoporosis would obviously involve loss of bone mineralization, as well as marrow oedema. Gout demonstrates typically 'rat's bite' para-articular erosions and soft-tissue calcification; when it involves the knee it tends to affect the patello-femoral compartment.

- 15 A lady suffers from long-standing rheumatoid arthritis. She is noted to have splenomegaly on a clinic visit. A diagnosis of Felty's syndrome is suspected clinically.

Which of the following is not a recognised feature of Felty's syndrome?

- (a) Ulceration *to the legs*  
(b) Neutropaenia  
(c) Skin pigmentation *(brown)*  
(d) Weight loss  
(e) Low titres of rheumatoid factor *X high titres*

*Felty syndrome = Long standing RA  
① Neutropenia  
② Splenomegaly*

15 (e)

Felty's syndrome is characterised by the combination of long-standing rheumatoid arthritis, splenomegaly and neutropaenia. Associated features include weight loss, leg ulceration, and brown skin pigmentation. Almost all have high titres of rheumatoid factor.

- 16 A patient presents with back pain. He is found to be HLA-B27 positive and a diagnosis of ankylosing spondylitis is suspected. Plain films of the spine are requested.

Which of the following would be the least supportive of this diagnosis?

- (a) Calcification of the anterior longitudinal ligament  
(b) Osteitis  
(c) Syndesmophytes  
(d) Sclerosis of the costovertebral joints  
(e) Ankylosis of the costovertebral joints

16 (a)

Ossification of the posterior, rather than anterior longitudinal ligament is typical of ankylosing spondylitis.



- 41 A patient with joint pain has plain radiographs of the hands and spine. The differential diagnosis is considered to be between psoriatic arthropathy and rheumatoid arthritis.**

**Which of the following features is more common in rheumatoid arthritis rather than psoriatic arthropathy?**

- (a) Phalangeal enthesophytes
- (b) Involvement of the distal interphalangeal joints
- (c) Fusiform soft tissue swelling of the digits
- (d) Asymmetric joint involvement
- (e) Involvement of the wrist joints

**41 (e)**

The wrists are more commonly involved in rheumatoid arthritis.

- 3 A patient presents with joint pain and plain radiographs are taken.**

**Which of the following features would favour the diagnosis of osteoarthritis over rheumatoid arthritis?**

- (a) Marginal erosions
- (b) 'High-riding' shoulder
- (c) Periarticular osteoporosis
- (d) Superolateral migration of the femoral head
- (e) Involvement of the proximal joints of the hand

**3 (d)**

In rheumatoid arthritis, the femoral head tends to migrate axially, whilst in osteoarthritis, it tends to migrate superolaterally.

- 10 A gentleman presents with knee swelling, pain and stiffness. Plain radiographs and subsequent MR imaging were performed, and a diagnosis of pigmented villonodular synovitis is suspected.**

**Which of the following is not typical of this disease?**

- (a) Preservation of bone density
- (b) Synovial low signal intensity on gradient echo MR imaging
- (c) Well-defined erosions on both sides of the joint
- (d) Joint space narrowing early in the disease
- (e) Joint effusion

**10 (d)**

Pigmented villonodular synovitis is a proliferation of synovium that occurs in joints, bursae and tendon sheaths. The joint space is well preserved until late in the disease.

- 30 A pelvic radiograph reveals sacroiliitis. This is most prominent on the lower and middle thirds of the joints, particularly on the iliac side. The changes are bilateral and symmetrical.**

**These appearances are most commonly seen in which of the following conditions?**

- (a) Reiter's syndrome
- (b) Rheumatoid arthritis
- (c) Gouty arthritis
- (d) Osteoarthritis
- (e) Ankylosing spondylitis

**30 (e)**

Ankylosing spondylitis typically produces a bilateral, symmetrical sacroiliitis, whilst the other conditions typically result in bilateral but asymmetrical disease. Other conditions producing bilateral, symmetrical sacroiliitis include: inflammatory bowel disease, psoriatic arthropathy, osteitis condensans ilii, hyperparathyroidism and paraplegia.

- 41 A 35 year old woman presents with gradually progressive knee pain over several years with locking of the joint. Plain radiographs show multiple round, well defined calcified loose bodies in the joint with no osteoporosis, and widening of the joint space.**

**Which of the following is the likeliest diagnosis?**

- (a) Synovial osteochondromatosis
- (b) Pigmented villonodular synovitis
- (c) Lipoma arborescens
- (d) Synovial sarcoma
- (e) Osteochondritis dissecans

**41 (a)**

Cross sectional imaging shows a soft tissue mass of near water attenuation on CT containing calcifications, and a lobulated intra-articular mass which is isointense to muscle on T1W and hyperintense on T2W with foci of low signal intensity.

- 45 A 25 year old man presents with chronic back pain. X-rays show bilateral irregularity of the sacro-iliac joints and paravertebral ossification on the AP view. Radiographs of the feet demonstrate destruction of the interphalangeal joint of the great toe with an exuberant periosteal reaction and bony proliferation at the distal phalangeal base.**

**Which of the following is the likeliest diagnosis?**

- (a) Ankylosing spondylitis
- (b) Rheumatoid arthritis
- (c) Psoriatic arthritis
- (d) Reiter's syndrome
- (e) Inflammatory bowel disease

**45 (c)**

The changes in the feet are characteristic of psoriatic arthropathy with soft tissue swelling and erosive changes leading to a 'pencil-in-cup' deformity. When seen, the changes at the interphalangeal joint of the great toe are pathognomonic. The SI joints are involved in 40% of cases and involvement can be either uni- or bi-lateral. As with Reiter's syndrome, a large bulky paravertebral area of ossification ('floating osteophyte') is often seen.

**56 A 50 year old man presents with gradual onset pain in multiple joints. Radiographs and MRI examinations show bilateral olecranon bursal effusions along with well defined, homogeneous, enhancing soft tissue masses which are isointense to muscle on T1W and hypointense on T2W which involve the wrist, ankle and knee joints.**

**What is the likeliest diagnosis?**

- (a) Rheumatoid arthritis
- (b) Gout
- (c) Pseudogout
- (d) Psoriasis
- (e) Amyloidosis

**56 (b)**

Gout is polyarticular in 10% of cases. The soft tissue components have characteristic appearances and may calcify. Bilateral olecranon bursal effusions are considered pathognomonic.

**62** A 45 year old woman has hand radiographs for multiple joint pains. The radiographs show fusion of the distal interphalangeal joints.

**Which of the following is the least likely diagnosis?**

- (a) Erosive osteoarthritis
- (b) Reiter's syndrome
- (c) Rheumatoid arthritis
- (d) Psoriatic arthropathy
- (e) Ankylosing spondylitis

**62 (c)**

In rheumatoid arthritis, the changes classically affect the MCP and PIP joints but spare the DIP joints.

3) Plain knee radiographs performed in accident and emergency following a sports injury in a 20-year-old footballer show an effusion, a small avulsion fracture immediately proximal to the fibular head, deepening of the lateral femoral sulcus and anterior translocation of the tibia. What is the most likely underlying ligamentous injury?

- a. complete posterior cruciate ligament rupture
- b. complete anterior cruciate ligament rupture
- c. partial anterior cruciate ligament rupture
- d. tibial collateral ligament rupture
- e. fibular collateral ligament rupture

3) b. \*\*

The avulsion fracture described is a Segond fracture, which is classically associated with anterior cruciate ligament (ACL) rupture, and represents avulsion of the meniscotibial portion of the middle third of the lateral capsular ligament. Anterior translocation of the tibia occurs in complete ACL rupture, and manifests clinically as the anterior draw sign. Also associated with ACL rupture is an impaction injury of the lateral femoral condyle, which can be seen on radiographs as a deepened lateral femoral condylar sulcus, although sometimes this cannot be identified on acute films.

6) Of the lateral fibrous structures contributing to the stability of the posterolateral corner of the knee, which is the most likely to be congenitally absent and not identified on MRI, being present in only approximately two-thirds of patients?

- a. lateral collateral ligament
- b. popliteus tendon
- c. popliteofibular ligament
- d. arcuate ligament
- e. fabellofibular ligament



6) d. \*\*\*\*

The structures of the posterolateral corner of the knee have a very important role in maintaining the rotational stability of the knee joint.

The lateral collateral ligament forms the superficial layer, with the remainder of the structures comprising the deep layer. Injury is relatively common and results most frequently from a varus force on an extended joint. The lateral collateral ligament and popliteus tendon are present in all joints, with the popliteofibular ligament being present in

approximately 98%. Both the arcuate ligament and fabellofibular ligaments are variable, with the former absent more frequently. Absence of one of these structures is often compensated for by hypertrophy of the other.

22) A 32-year-old woman with a long history of right knee pain undergoes radiography for atraumatic swelling of the joint and is found to have an effusion and soft-tissue swelling but no other findings. MRI shows a large anterolateral lobular intra-articular mass of low signal on T1W and T2W images, and a blooming artefact is seen on gradient echo sequences. What is the most likely condition?

- a. malignant fibrous histiocytoma
- b. pigmented villonodular synovitis
- c. synovial osteochondromatosis
- d. Baker's cyst
- e. intra-articular haematoma

22) b. \*\*\*

Pigmented villonodular synovitis is a benign proliferative disorder of the synovium that has a propensity for young to middle-aged adults and typically has a long history. On plain radiographs, joint space and bone mineralization are typically preserved until late in the disease, but soft-tissue swelling or effusion may be apparent early on. Haemorrhage is relatively common and can result in haemarthrosis and blooming artefact seen on gradient echo MRI sequences. Malignant fibrous histiocytoma is the most common soft-tissue sarcoma after age 50. Synovial osteochondromatosis is more common in men and is characterized by proliferation of the synovium with formation of cartilaginous nodules (that often calcify), but does not show haemorrhage. Baker's cyst has synovial fluid characteristics on MRI and is located posterior to the joint.

30) MRI of the knee in an 18-year-old man, performed for pain and limited joint movement, reveals an osteochondral lesion of the medial femoral condyle. Other than displacement, which MRI finding is the most specific indication of an unstable osteochondral fragment?

- a. joint effusion
- b. subfragmental bone resorption
- c. 3 mm cyst deep to the lesion
- d. underlying linear high signal on T2W images
- e. multiple lesions

30) d. \*\*\*

High T2 signal in the bone underlying an osteochondral lesion has been described as the most common of four MRI findings indicating instability of an osteochondral fragment, which is the most important factor when considering treatment options. The reported accuracy of this sign for predicting instability varies from 45% to 85%, with one study reporting an increased accuracy when this sign is combined with the second sign of a cartilaginous defect on T1W images. However, another study states that often only a single indicator is present. The other indicators of instability are high signal in the articular cartilage and a cystic lesion in the bed (but this needs to be 5 mm or larger).

50) O'Donoghue's unhappy triad consists of injuries to which three internal structures of the knee that are commonly injured together?

- a. anterior cruciate and lateral collateral ligaments, medial meniscus
- b. anterior cruciate and lateral collateral ligaments, lateral meniscus
- c. anterior cruciate and medial collateral ligaments, medial meniscus
- d. anterior cruciate and medial collateral ligaments, lateral meniscus
- e. posterior cruciate ligament, medial and lateral menisci

50) c. \*\*

O'Donoghue's unhappy triad consists of injuries to the anterior cruciate and medial collateral ligaments and the medial meniscus, and is an injury associated with contact sports. The mechanism is indirect trauma

causing deceleration, hyperextension and twisting forces. The combination of external rotation of the tibia on the femur, knee flexion and valgus stress can produce an anterior cruciate ligament injury combined with additional medial collateral ligament injury. The meniscus and collateral ligament medially are attached to one another, unlike their lateral counterparts, resulting in a higher frequency of concordant injury to the other medial structure when one is injured.

75) A 16-year-old female gymnast sustains a twisting injury to the knee, which becomes immediately painful and swollen, and she is unable to bear weight. Initial radiographs show an effusion but are otherwise normal. MRI confirms a joint effusion with a torn medial retinaculum, marrow oedema affecting the anterior aspect of the lateral femoral condyle, and a chondral defect of the medial facet of the patella. What is the most likely injury?

- a. lateral collateral ligament tear
- b. medial meniscal tear
- c. pivot shift injury
- d. transient patellar dislocation
- e. posterolateral corner syndrome

75) d. \*\*  
Transient patellar dislocation always occurs laterally and was originally thought to be an injury confined to teenage girls with abnormal

patellofemoral anatomy, but is now considered a potential injury in anyone who partakes in athletic activity. The most common finding is effusion and lateralization of the patella with or without an abnormally shallow femoral sulcus. Other findings seen on MRI are contusions of the lateral femoral condyle and medial patella with potential osteochondral defects, and disruption or sprain of the medial retinaculum. Less-specific findings include loose bodies and associated ligamentous or meniscal injury.



99) A young footballer sustains a twisting injury to the right knee in training. He is able to continue practising but complains of moderate medial knee pain. The following morning he wakes with a swollen stiff joint. Radiographs show an effusion only. Subsequent MRI confirms an effusion and reveals a truncated medial meniscus with a 'bow-tie' configuration seen on only a single sagittal image. Sagittal sequences reveal a 'double' appearance of the posterior cruciate ligament. He has not had any previous surgery. What is the most likely injury or combination of injuries? *Bucket handle*

- a. torn medial meniscus
- b. torn medial meniscus and anterior cruciate ligament
- c. torn medial meniscus and posterior cruciate ligament
- d. torn anterior cruciate ligament
- e. torn posterior cruciate ligament

99) a. \*

Truncation of a meniscus may be due to previous injury or surgical resection, but in the absence of a relevant history it suggests meniscal tear with displacement of the body of the meniscus. On sagittal sequences, one would normally expect to see a full 'bow-tie'-shaped meniscus on three or more contiguous images, as the meniscal body is approximately 11 mm in thickness (this of course will depend on slice thickness). Any fewer suggests a meniscal body tear with displacement of the fragment. The fragment often flips into the intercondylar groove of the femur to lie anterior and parallel to the posterior cruciate ligament, giving the impression of two similar structures. This injury is known as a bucket-handle tear.

2. A 35 year old man presents with increasing stiffness in his knee and soft-tissue swelling around the joint. Plain films show multiple areas of irregular cyst-like radiolucencies in the distal femur. There are no areas of abnormal calcification and there is no evidence of periarticular osteoporosis. MR shows a low signal joint effusion on both T1 and T2 sequences. The most likely diagnosis is:
- Synovial osteochondromatosis
  - Pigmented villonodular synovitis
  - Osteoarthritis
  - Reiter's syndrome
  - Osteomyelitis

**2. b. Pigmented villonodular synovitis**

Pigmented villonodular synovitis is a relatively rare condition which usually presents in the third or fourth decade. It is a monoarticular, painful disease which causes a decreased range of movement at the affected joint. It is most common at the knee (80%) followed by the hip, ankle, shoulder and elbow. Haemorrhagic 'chocolate' effusion is characteristic. Low signal effusion on all sequences at MR is characteristic. There is no calcification or osteoporosis, and joint space narrowing is a late feature.

10. A 24 year old man injured his left knee whilst skiing. He presents with pain and swelling over the lateral aspect of the knee joint. AP plain radiographs demonstrate an avulsion fracture of the lateral aspect of the proximal tibia below the articular surface. A joint effusion is also seen. The most likely associated ligamentous injury is to which of the following structures?
- Posterior cruciate ligament
  - Anterior cruciate ligament
  - Medial collateral ligament
  - Lateral collateral ligament
  - Ligament of Humphry

**10. b. Anterior cruciate ligament**

The fracture described is a Segond fracture, originally documented by Dr Paul Segond in 1879 after a series of cadaveric experiments. The Segond fracture occurs most commonly in association with anterior cruciate ligament injuries (75–100%) and medial meniscal injuries. Due to the high rate of associated injuries, a patient who sustains a Segond fracture will require further imaging, usually by way of MRI, in order to specifically investigate the ligaments and menisci.



57. A 64 year old woman undergoes MRI of her left knee for investigation of chronic knee pain. Which of the following would be considered an abnormal finding on MR?
- a. Bowing of the posterior collateral ligament on sagittal imaging
  - b. Low signal ACL on T1-weighted imaging
  - c. High signal around the MCL on T2\* on coronal imaging
  - d. Low signal of the menisci on both T1- and T2-weighted imaging
  - e. Medial patellar plica

**57. c. High signal around the MCL on T2\* on coronal imaging**

The only abnormal finding is the presence of high signal around the MCL on T2\* imaging. This would represent oedema or haemorrhage around the MCL and may be associated with a tear. Bowing of the PCL occurs when the knee is extended. A medial patellar plica is

a normal finding in approximately 50% of the population. This is an embryological remnant from when the knee was divided into three compartments.

- 17 A 37-year-old female with a long history of right knee pain is eventually diagnosed with pigmented villonodular synovitis (PVNS). What are the most likely findings on imaging?
- a Marked joint space narrowing
  - b High signal of abnormal synovium on all MRI sequences
  - c Expansion of prefemoral fat pad
  - d Sclerotic deposits in articular surfaces
  - e Joint effusion

**17 Answer E: Joint effusion**

The knee is the most common location for PVNS. The soft tissues appear dense due to haemosiderin deposits and there are multiple sites of cyst-like radiolucent defects due to bone invasion. There is not usually any evidence of calcification, osteoporosis and joint space narrowing until later on. There is low signal on all sequences due to the presence of haemosiderin. Other features include: knee joint effusion on plain films, scalloping of pre-femoral fat pad, soft-tissue mass around joint, no joint space narrowing.

- 22 A 16-year-old athlete presented with a history of locking of his knee following an injury. His plain radiograph demonstrates a small opacity within the joint space. What is the most likely diagnosis?
- a Intra-articular loose body
  - b Calcium pyrophosphate deposition disease (pseudogout)
  - c Heterotopic ossification
  - d Anatomical variant
  - e Osteochondral fracture of the medial femoral condyle

22 Answer A: Intra-articular loose body

- 30 A 56-year-old plumber complained of long-standing bilateral pain anterior to his knees. There was no history of trauma although he reports spending two hours a day kneeling. AP, lateral and skyline radiographs of both knees showed soft-tissue swelling anterior to the patella but no bony abnormality. What is the most appropriate further management?
- a 1.5T MRI
  - b Unenhanced CT
  - c 3.0T MRI
  - d Arthroscopy
  - e No further imaging – rest and occupational modification alone are adequate

30 Answer E: No further imaging – rest and occupational modification alone are adequate

The history is highly suggestive of pre-patellar bursitis. Hence no further imaging is required. Removal of provocative factors and rest are normally adequate. Use of kneepads may also be of benefit. Complications such as secondary infection may necessitate antibiotic therapy.

- 3 A fit and well 72-year-old female presented to her general practitioner with medial knee pain, having twisted her knee four months previously. Initial films on attendance at the Emergency Department at the time of the injury were reported as normal. Repeat films several months later on showed flattening of part of the medial condyle and a radiolucent focus. Which of the following is the most likely diagnosis?
- a Panner's disease
  - b Metastasis
  - c Benign cortical defect
  - d Lymphoma
  - e Spontaneous osteonecrosis of the knee

3 Answer E: Spontaneous osteonecrosis of the knee (SONK)

This condition is most common in the seventh decade (range of 13–83 years) and occurs with acute pain. It is thought to be associated with a meniscal tear and microfractures (secondary to trauma), but there are multiple predisposing causes. An early bone scan (<5 weeks) would show pathology. Findings on delayed films include:

- flattening of the weight-bearing area of the medial femoral condyle;
- a radiolucent focus in the subchondral bone;
- later, subchondral fracture and periosteal reaction, which can lead to osteoarthritis in around half.

Panner's disease is osteonecrosis of the capitellum. The history is too acute for metastases or lymphoma. A benign cortical defect is more likely in first and second decades and is usually asymptomatic.

- 6 A 69-year-old female who had a right total knee replacement four years ago returns to clinic with knee pain. Her inflammatory markers and plain films are normal. A three-phase bone scan shows no increased uptake on dynamic or blood pool images, but static images show focal linear horizontal uptake in the medial tibial compartment adjacent to tibial component. Which is the most likely explanation?
- a Early loosening of prosthesis
  - b Subclinical infection
  - c Weight-bearing load area of knee producing uptake
  - d Normal findings at this post-operative stage
  - e Referred pain from hip

6 Answer C: Weight-bearing load area of knee producing uptake

Bone scan appearances of knee replacements can take up to 18 months to normalise, as it is such a dynamic, weight-bearing joint. Loosening should be correlated with plain film findings such as adjacent bone lucency. The presence of normal inflammatory markers is reassuring, but subclinical infection should be considered with increased uptake in dynamic imaging. The hips and spine should be routinely imaged in lower limb pain to exclude referred pain. Load bearing changes on the medial aspect of the tibial plateau are not specific to joint replacements and in this case is the most likely cause of the pain.

- 24 A 12-year-old boy presented with a painful, swollen left knee after a football injury. AP and lateral radiographs of the knee demonstrated a bone fragment on the lateral aspect of the knee that was felt to be secondary to popliteus tendon avulsion. What is the function of the popliteus muscle?
- a It locks the knee
  - b It is an extensor of the knee joint
  - c It controls lateral meniscal displacement
  - d It limits anterior tibial translation
  - e It is a flexor of the knee joint

24 Answer C: It controls lateral meniscal displacement

The popliteus muscle unlocks the knee from a position of full extension by internally rotating the tibia. It therefore initiates knee flexion. It limits posterior tibial translation and prevents excessive external rotation and varus rotation of the tibia during knee flexion. It is part of the structures of the posterolateral corner of the knee.

- 31** A footballer was tackled from behind while playing in his local park. He felt a sudden 'pop' and his knee became swollen and unstable. While waiting for an MRI scan he noticed his leg pivoted outward about his knee as he walked. What are the most likely findings on the MRI scan?
- a MCL rupture due to valgus stress
  - b LCL rupture due to direct blow
  - c MCL rupture due to varus stress
  - d LCL rupture due to varus stress
  - e MCL rupture due direct blow

**31** Answer A: MCL rupture due to valgus stress

Isolated medial collateral ligament (MCL) injuries usually result from a valgus stress without a rotary component. They are more commonly associated with other injuries (e.g. ACL and medial meniscal tears) but isolated MCL tears are sometimes seen.

- 68** A 37-year-old female presented with anterior knee pain and was investigated with an MRI scan. There was thinning of the cartilage in the patello-femoral joint, but no abnormality in the femoro-tibial joint. What is the most likely diagnosis?
- a Septic arthritis
  - b Osgood-Schlatter disease
  - c Sinding-Larsen-Johansson disease
  - d Chondromalacia patella
  - e Patella dislocation

**68** Answer D: Chondromalacia patella

This common condition is due to softening of the articular cartilage and is often associated with patella maltracking. It is very often an asymptomatic finding at arthroscopy performed for another reason.

- 30 A 19-year-old hockey player self-referred for physiotherapy for treatment of a long-standing knee problem. A recent radiograph had been reported: 'There is flattening and cortical irregularity of the lateral surface of the medial femoral condyles bilaterally. Subchondral cysts and subchondral sclerosis are present, more marked on the right side.' What is the most likely diagnosis?
- a Osgood-Schlatter disease
  - b Osteoarthritis
  - c Juvenile chronic arthritis
  - d Psoriatic arthritis
  - e Osteochondritis dissecans

30 Answer E: Osteochondritis dissecans

Osteochondritis dissecans typically affects the lateral surface of the medial femoral condyle in adolescent males but may also involve the weight-bearing surface of the lateral femoral condyle, tibia or patella. A fragment may separate from the underlying bone and present as an intra-articular loose body (approximately 50% of cases) with pain, swelling and locking of the knee. The condition is bilateral in 20–25% of cases. Osgood-Schlatter disease is the eponym for traction apophysitis of the tibial tuberosity. Subchondral sclerosis and cysts are hallmarks of degenerative arthritis, although the patient's age makes this much less likely.

- 34 A 45-year-old man with knee pain and instability after a ski injury is assessed in the Orthopaedic Clinic. Clinical examination reveals anterior knee instability with a positive anterior drawer and McMurray test. There is slight crepitus and joint line tenderness. AP and lateral radiographs of the knee are performed, which reveal a small bony fragment just lateral to the lateral tibial plateau. What is the most likely combination of findings?
- a Medial meniscus and anterior cruciate ligament tear
  - b Lateral meniscus and anterior cruciate ligament tear and reverse Segond fracture
  - c Posterior cruciate ligament and joint capsule tears
  - d Sesamoid bone in biceps femoris tendon and ligamentous injuries
  - e Medial meniscus, anterior cruciate ligament tear and Segond fracture



**34** Answer E: Medial meniscus, anterior cruciate ligament tear and Segond fracture

A Segond fracture is a capsular avulsion fracture seen at the lateral aspect of the proximal tibia and is often associated with high-energy sporting and ski injuries. There is usually associated ACL and meniscal injury and a medial tibial plateau impaction fracture may be present. A reverse Segond fracture is an avulsion fracture of the medial tibial margin. It is strongly associated with medial meniscal and PCL tears and caused by severe hyperextension and valgus stress.

**61** A 23-year-old man was investigated with an MRI scan for knee symptoms following an injury playing football four weeks before. On the sagittal images the posterior cruciate ligament was intact but followed an obviously curved course. What underlying injury is likely?

- a None – normal variant
- b Anterior cruciate ligament tear
- c Patella tendon tear
- d Lateral collateral ligament tear
- e Medial collateral ligament tear

**61** Answer B: Anterior cruciate ligament tear

The PCL is bowed due to posterior translation of the femur on the tibia. There is very often an associated meniscal tear.

**66** A 40-year-old woman presented with a long history of a painful joint and was found to have pigmented villonodular synovitis (PVNS). Which joint was most likely to have been affected?

- a Ankle
- b Elbow
- c Hip
- d Knee
- e Shoulder

**3. A 25-year-old male presents with a history of dislocation and spontaneous relocation of the patella while playing football. An MRI of the knee is requested. Which of the following findings is consistent with the clinical history of patellar dislocation?**

- A. Bone oedema involving medial facet of patella and medial femoral condyle.
- B. Bone oedema involving posterior patella and anterior aspect of the tibial plateau.
- C. Bone oedema involving the lateral facet of patella and lateral femoral condyle.
- D. Bone oedema involving the lateral facet of patella and medial femoral condyle.
- E. Bone oedema involving the medial facet of patella and lateral femoral condyle.

**3. E.** Bone oedema involving the medial facet of patella and lateral femoral condyle.

Transient dislocation of the patella typically occurs laterally as a result of a twisting injury in a fixed and flexed knee. The medial facet of the dislocated patella impacts against the lateral femoral condyle, resulting in the classic bone contusion pattern. Rarely oedema may also be seen in the adductor tubercle of the medial femoral condyle due to avulsion of the medial patello-femoral ligament.

**19. A patient attends A&E following an RTA in which she was the driver of car involved in a head-on collision. She complains of pain in both knees. Plain radiographs of the knees are unremarkable. Which of the following findings on MRI is most likely?**

- A. Bruising in the posterior aspect of the lateral tibial plateau and middle portion of the lateral femoral condyle.
- B. Bruising at the anterior aspect of the tibia.
- C. Kissing contusions in the anterior aspect of the distal femur and proximal tibia.
- D. Bruising in the lateral femoral condyle with a second smaller area in the medial femoral condyle.
- E. Bruising in the inferior medial patella and the anterior aspect of the lateral femoral condyle.

**19. B.** Bruising at the anterior aspect of the tibia.

Such bruising occurs in a dashboard injury when a posteriorly directed force is applied to the anterior aspect of the proximal tibia with the knee in flexion, such as occurs in an RTA. Bruising is also occasionally found in the posterior patella in this situation. Associated soft-tissue injuries are disruption of the posterior capsule and posterior cruciate ligament (PCL).

The pattern of injury in option A is caused by the pivot shift injury (valgus load in flexion combined with external rotation of the tibia or internal rotation of the femur). This will result in

anterior cruciate ligament (ACL) disruption and the resultant anterior subluxation of the tibia causes impaction of the lateral femoral condyle against the posterolateral margin of the lateral tibial plateau. Soft-tissue injuries that may occur are tears of the posterior capsule, the posterior horn of the lateral or medial meniscus, and the medial collateral ligament (MCL). The kissing contusions in option C are as a result of hyperextension injury; resulting injuries may be to the ACL, PCL, or menisci. Option D describes the pattern found in clip injury, which involves a pure valgus stress while the knee is in mild flexion. The second area of bruising in the medial femoral condyle in this situation is due to avulsive stress to the MCL. The findings in option E are in keeping with transient lateral patellar dislocation, as discussed elsewhere in this chapter.

**21. A 54-year-old man presents with a swelling in his right popliteal fossa. A Baker's cyst is suspected clinically and an ultrasound scan is arranged. This confirms a complex cystic structure with debris. To help confirm this is a Baker's cyst, you look for a communication of this cyst with fluid at the posterior aspect of the knee joint between which two tendons?**

- A. Semitendinosis and lateral head of gastrocnemius.
- B. Semitendinosis and medial head of gastrocnemius.
- C. Semitendinosis and semimembranosis.
- D. Medial and lateral heads of gastrocnemius.
- E. Lateral head of gastrocnemius and semimembranosis.
- ✓ F. Medial head of gastrocnemius and semimembranosis.

**21. F.** Medial head of gastrocnemius and semimembranosis.

Identification of anechoic cysts communicating with fluid between the semimembranosis and gastrocnemius tendons confirms the diagnosis of Baker's cyst. It is important to perform further imaging if the mass in the posterior compartment lacks signs of communication with fluid between the semimembranosis and medial gastrocnemius tendons. If this is the case, there are other possibilities for the lesion, including meniscal cyst or even a myxoid sarcoma.



**41. A 15-year-old boy presents with a history of knee pain. Plain radiographs demonstrate calcification at the patellar tendon attachment to the inferior pole of the patella. MRI of the knee demonstrates oedema at the patellar attachment of the patellar tendon. What is the diagnosis?**

- A. Osgood–Schlatter disease.
- B. Patellar sleeve avulsion.
- C. Sinding–Larsen–Johansson syndrome.
- D. Complete rupture of patellar tendon.
- E. Partial tear of quadriceps tendon.

**41. C.** Sinding–Larsen–Johansson syndrome.

This is a traction tendonitis occurring at the attachment of the patellar tendon to the inferior pole of the patella. Repetitive stress/microtrauma at the tendinous attachment results in calcification or ossification of the tendon on the plain film. MRI demonstrates oedema within the tendon and at the inferior pole of the patella.

Similar changes occurring at the tibial attachment of the patellar tendon is called Osgood–Schlatter disease.

Patellar sleeve fracture is a unique paediatric injury in which the cartilage at the inferior pole of the patella is avulsed along with a small bone fragment.

The quadriceps tendon inserts into the superior pole of the patella, therefore a partial tear produces oedema at the superior pole of the patella.

**65. A 24-year-old man undergoes acute trauma to his right knee playing football. He is unable to weight bear. An x-ray of the right knee is performed and this demonstrates a large joint effusion and a small, avulsed elliptical fragment of bone at the medial aspect of the proximal tibia at the joint margin. Which knee structure is likely to be deranged in association with this injury at a subsequent MRI?**

- A. Anterior cruciate ligament.
- B. Posterior cruciate ligament.
- C. Lateral collateral ligament.
- D. Patellar tendon.
- E. Lateral meniscus.

**65. B. Posterior cruciate ligament.**

The avulsion injury described is a reverse Segond fracture. This injury is known to be associated with both mid-substance tears of the posterior cruciate ligament and avulsions of the PCL from the posterior tibial plateau. They can also be associated with medial meniscus injuries. They are not to be confused with a Segond fracture, which is a small elliptical fragment of bone avulsed from the lateral tibial plateau at the lateral joint margin, best seen on the AP view of the knee. They have a strong association with tears of the anterior cruciate ligament and also meniscal tears.

**75. A 35-year-old man presents with pain, swelling, and reduced movement of his knee. A plain film reveals a joint effusion, well-defined erosions with preservation of joint space, and normal bone mineralization. An MRI reveals, in addition, a mass in the region of the femoro-tibial joint space with low signal on T1WI and T2WI, and blooming artefact on GE imaging. What is the most likely diagnosis?**

- A. Synovial cell sarcoma.
- B. Regional migratory osteoporosis.
- C. Gout.
- D. Synovial chondromatosis.
- E. PVNS.

**75. E. PVNS.**

This is a monoarticular tumour-like proliferation of synovium that occurs in joints, bursae, and tendon sheaths. It may be focal or diffuse. It occurs most frequently in the knee (80% of cases), then the hip, ankle, shoulder, and elbow. The abnormal synovium is prone to haemorrhage, thus producing blooming artefact on GE sequences, secondary to haemosiderin deposition. In general the classic MRI appearance is variable low signal intensity on all sequences (T2WI signal being more variable due to fat, oedema, and blood products). Early changes involve a focal mass and joint effusion. Subsequently large erosions, synovial hypertrophy, and subchondral cysts may occur. Joint space is preserved until advanced disease is present and bone density is normal. After IV contrast at CT, PVNS shows variable enhancement, which can be striking. The differential diagnosis includes diseases causing recurrent haemarthroses, e.g. haemophilia and haemochromatosis (PVNS is monoarticular) as well as gout, amyloid, synovial chondromatosis, and tuberculosis.

Some 90% of synovial cell sarcomas do not originate from a joint. They are usually isointense to muscle on T1WI, with heterogeneous high-signal intensity on T2WI. Regional migratory osteoporosis would obviously involve loss of bone mineralization, as well as marrow oedema. Gout demonstrates typically 'rat's bite' para-articular erosions and soft-tissue calcification; when it involves the knee it tends to affect the patello-femoral compartment.

- 2 A 35 year old man suffers a knee injury during a football match and presents with pain, swelling, knee locking and an inability to fully extend his knee. He undergoes an MRI examination.

**What is the most common site of injury?**

- (a) Anterior cruciate ligament
- (b) Posterior cruciate ligament
- (c) Anterior horn medial meniscus
- (d) Posterior horn medial meniscus
- (e) Anterior horn lateral meniscus

2 (d)

The symptoms described are more consistent with those of a meniscal injury, rather than a ligamentous tear. Such tears are commonest in the posterior horn of the medial meniscus.

- 33 A patient has injured his knee and is unable to weight bear. AP and lateral radiographs are taken.

**Which of the following is an abnormal finding?**

- ✓ (a) On the lateral view, the distance from the lower pole of the patella to the tibial tubercle is 1.5 times the length of the patella *Patellar tendon on lateral view is 1.5 times length of patella*
- (b) There is irregularity of the tibial tubercle
- (c) On the AP view, a perpendicular line drawn from the lateral margin of the femoral condyle has 3 mm of the lateral margin of the tibial condyle outside of it *upto 5mm is normal*
- (d) There is a corticated, calcified body in the lateral head of the gastrocnemius muscle *⇒ fabella*
- (e) There is a multipartite patella



**33 (a)**

On the lateral view, the distance from the lower pole of the patella to the tibial tubercle should equal the length of the patella plus or minus 20%. If this rule is broken, a ruptured patellar ligament must be suspected. On the AP view a perpendicular line drawn from the lateral margin of the femoral condyle should have  $\leq 5$  mm of the lateral margin of the tibial condyle outside of it. The fabella is a common sesamoid bone within the lateral head of gastrocnemius.

**40 A patient presents with suspected transient patellar dislocation. MR imaging is performed.**

**Which of the following MR imaging features would be least expected in this condition?**

- (a) Disruption of the medial retinaculum
- (b) Lateral patellar tilt
- (c) Elevation of the vastus medialis obliquus muscle
- ✗ (d) Bone contusion of the medial aspect of the medial femoral condyle
- (e) Bone contusion of the inferomedial aspect of the patella

**40 (d)**

In transient patella dislocation, the patella dislocates laterally and then relocates. This causes impaction between the inferomedial aspect of the patella and the anterolateral aspect of the lateral femoral condyle, which results in bone contusions. In addition to the above signs, a haemarthrosis is also usually present.

- 10 A gentleman presents with knee swelling, pain and stiffness. Plain radiographs and subsequent MR imaging were performed, and a diagnosis of pigmented villonodular synovitis is suspected.**

**Which of the following is not typical of this disease?**

- (a) Preservation of bone density
- (b) Synovial low signal intensity on gradient echo MR imaging
- (c) Well-defined erosions on both sides of the joint
- (d) Joint space narrowing early in the disease
- (e) Joint effusion

**10 (d)**

Pigmented villonodular synovitis is a proliferation of synovium that occurs in joints, bursae and tendon sheaths. The joint space is well preserved until late in the disease.

- 38 A teenager presents with recurrent patella dislocations. Radiographs reveal hypoplastic patellae and bilateral posterior iliac horns.**

**Which of the following is an unlikely association?**

- (a) Renal dysfunction
- (b) Short 5th metacarpal
- (c) Hypoplastic radial head
- (d) Scoliosis
- (e) Hypoplastic recessed anterior iliac spines

**38 (e)**

Nail-patella syndrome (also known as Fong's disease) is described. This is a rare autosomal dominant disorder characterised by symmetrical meso- and ecto-dermal anomalies. Bilateral posterior iliac horns (seen in 80%) are diagnostic. Renal dysfunction is the commonest serious complication. A flared iliac crest with protuberant anterior iliac spines are seen.

- 53 A 15 year old boy presents with a history of right knee clicking, locking and intermittent swelling. There is no clear history of trauma. MRI shows a focus of abnormal signal in the subarticular marrow, a defect in the overlying cartilage, a loose intra-articular body and a small effusion.**

**What is the likeliest site of the cartilaginous defect?**

- (a) Medial aspect of the lateral condyle
- (b) Lateral aspect of the lateral condyle
- (c) Medial aspect of the medial condyle
- (d) Lateral aspect of the medial condyle
- (e) Posterior surface of the patella

**53 (d)**

Osteochondritis dissecans is the fragmentation and sometimes separation of a portion of the articular surface usually seen in adolescent males. It is most commonly related to repetitive microtrauma although associations with other conditions such as Osgood-Schlatter's and Scheuerman's disease have been reported. It is most common in the medial femoral condyle although the humerus, capitellum and talus may be involved. It is bilateral in 10–20%.

- 60 A 30 year old man is hit by a car sustaining a 'bumper' type injury. Radiographs show a bicondylar tibial plateau fracture with an 'inverted Y' appearance.**

**In the Schatzker classification, which type of fracture is this?**

- (a) I
- (b) II
- (c) III
- (d) IV
- (e) V

**60 (e)**

Type I (6%) is a pure wedge shaped cleavage fracture. Type II (25%) is a mixed cleavage and median compression fracture. Type III (36%) is a pure compression (depression) fracture. Type IV (10%) is a medial comminuted plateau fracture. Type VI (20%) is a transverse/oblique fracture separating the metaphysis from the diaphysis. Type V fractures are the rarest.

2) A 30-year-old woman presents to her general practitioner with fatigue and painful stiff knees. She is subsequently found to be anaemic. Plain films show an Erlenmeyer flask deformity of the distal femora with cortical thinning. There are no erosions. What is the most likely underlying condition?

- a. mucopolysaccharidosis
- b. rheumatoid arthritis
- c. Gaucher's disease
- d. Langerhans' cell histiocytosis
- e. thalassaemia major

2) c. \*\*\*

Gaucher's disease is the most common lysosomal storage disorder with an incidence of 1:50 000 (100 times more common in Ashkenazi Jews). It is caused by a defect of hydrolase acid  $\beta$ -glycosidase, which results in accumulation of the fatty substance glucosylceramide within macrophages in the reticuloendothelial system. It characteristically causes an Erlenmeyer flask deformity of the distal femur or proximal tibia due to marrow infiltration. Patients may be asymptomatic or present with anaemia, large joint stiffness or bone pain. Diagnosis is by bone marrow aspirate. The mucopolysaccharidoses are a spectrum of lysosomal storage diseases that typically present in infancy with a variety of overt symptoms and signs. Rheumatoid arthritis can present with anaemia and joint stiffness, but marrow infiltration is not a feature on plain film. Musculoskeletal manifestations of Langerhans' cell histiocytosis most commonly affect the skull (50%). Although Erlenmeyer flask deformity is seen in thalassaemia major, presentation is within the first 2 years of life.

20) As seen on radiographs of a paediatric skeleton, generalized appendicular findings of poor mineralization of the epiphyseal centres, widening of the growth plate and cupping/fraying of the metaphyses are all frequently associated with which condition?

- a. osteogenesis imperfecta
- b. scurvy
- c. fibrous dysplasia
- d. rickets
- e. mucopolysaccharidosis

20) d. \*

Rickets (vitamin D deficiency) results in failure of normal bone mineralization (osteomalacia) during bone growth and may have a dietary, cultural or metabolic cause. A widened growth plate in a child is due to rickets until proven otherwise. Other features include bowing deformity, metaphyseal cupping and/or fraying, poor epiphyseal mineralization, delayed closure of the fontanelles, enlargement of the costochondral junction (rachitic rosary) and craniothoracic. Scurvy is a deficiency of vitamin C and is primarily a disorder of collagen

production, resulting in osteopenia with dense metaphyseal lines and a sclerotic rim around the epiphysis.

25) Looser's zones – transverse linear lucencies representing areas of poorly mineralized osteoid – are seen with which underlying pathological process of bone?

- a. fracture
- b. osteomyelitis
- c. osteoporosis
- d. osteopetrosis
- e. osteomalacia

answer is c. osteoporosis



25) e. \*\*

Looser's zones or Milkman's pseudofractures are seen as linear lucencies in the bone due to incomplete fractures that have non-mineralized osteoid deposited within them. The underlying failure of bone to mineralize is termed 'osteomalacia' (which means bone softening), and is most often due to vitamin D deficiency. Rickets is osteomalacia in an immature skeleton. The most common conditions resulting in an osteomalacic process and inadequate bone mineralization include renal osteodystrophy and vitamin D deficiency due to malnutrition/malabsorption of vitamin D or phosphate.

29) On lateral radiographs of the thoracolumbar spine, a central anterior beak of the vertebral bodies is most likely to suggest which of the following conditions?

- a. Scheuermann's disease *no beak*
- b. Morquio's syndrome
- c. Hurler's syndrome *inferior beak*
- d. Down's syndrome *inferior beak*
- e. achondroplasia *inferior beak*

29) b. \*\*\*

Morquio's syndrome is type IV and the most common of the mucopolysaccharidoses, a family of inherited disorders of metabolism. A central vertebral beak is relatively specific for the condition. Other spinal manifestations include odontoid hypoplasia with atlantoaxial subluxation (which can be life threatening), platyspondyly, ovoid vertebral bodies, widened intervertebral disc space and exaggeration of the normal lumbar lordosis. Other skeletal findings include dwarfism, as well as skull, face and appendicular abnormalities. Hurler's syndrome belongs to the same family of disorders but has an inferior vertebral

beak, which is also seen in achondroplasia and Down's syndrome. Scheuermann's disease does not show vertebral beaking.

37) Vertebral sclerosis confined to the upper and lower endplates with preservation of the intervertebral disc space ('rugger jersey spine'), is seen most commonly with which underlying condition?

- a. osteoporosis
- b. discitis *causes reduction of intervertebral disc space with indistinct endplate*
- c. mucopolysaccharidosis *cause beaking rather than sclerosis*
- d. Paget's disease
- e. renal osteodystrophy *ie secondary hyperparathyroidism*

37) e. \*\*\*

The 'rugger jersey spine' appearance refers to sclerotic bands along the superior and inferior endplates of the thoracic and lumbar vertebral bodies. These bands represent accumulation of excess osteoid and result in a striped appearance of the vertebral bodies. Despite being poorly mineralized, the accumulated osteoid appears opaque on plain radiographs because of its increased volume compared with that of normal bone. The 'rugger jersey spine' is said to be almost pathognomonic for the osteosclerosis seen with the secondary hyperparathyroidism of chronic renal failure. Renal osteodystrophy is a term for the constellation of musculoskeletal abnormalities occurring with chronic renal failure. Osteoporosis and Paget's disease are more likely to affect the whole of the vertebrae diffusely. Discitis usually causes a reduction in the intervertebral disc space on radiographs, with indistinct endplates. The mucopolysaccharidoses result in anterior vertebral body beaking rather than sclerosis.

69) Plain radiographs of the knees are performed in a teenage girl with growth retardation and painful, deformed lower limbs. Which radiographic finding would suggest a diagnosis of scurvy rather than rickets?

- a. pathological fractures
- b. bowing deformity
- c. widened growth plate
- d. frayed metaphysis
- e. sclerotic epiphyseal rim

69) e. \*\*

Rickets is a deficiency of vitamin D in a child that results in osteomalacia of the immature skeleton. Scurvy is a deficiency of vitamin C and is a disorder of collagen synthesis that can occur in children or adults. Pathological fractures may be seen in both conditions. Ground-glass osteoporosis is characteristic of scurvy, with other features including a sclerotic line in the metaphyseal zone of preparatory calcification (white line of Fränkel), a radiolucent zone immediately to the diaphyseal side of the white line (Trümmerfeld's zone), corner fractures (Parke's corner sign) and a sclerotic ring around the epiphysis (Wimberger's sign). In addition, bleeding diathesis is seen in scurvy; therefore, subperiosteal haematoma and haemarthrosis are also features.

73) A 70-year-old man has plain radiographs of the hands and knees for joint pain and swelling, which show joint space narrowing and chondrocalcinosis. Which additional finding would support a diagnosis of haemochromatosis over pseudogout?

- a. periarticular calcium deposition
- b. metacarpal hooked osteophytes
- c. eccentric joint space narrowing
- d. large subchondral cysts
- e. intra-articular loose bodies

73) b. \*\*\*

Haemochromatosis is excess iron deposition in the tissues and can be either primary (autosomal recessive genetic disorder) or secondary to ineffective erythropoiesis or iron overload. Skeletal manifestations include osteoporosis (which is proportional to the extent of iron deposition), small subchondral cysts, arthropathy (50%), concentric joint space narrowing, chondrocalcinosis, and characteristic hooked osteophytes on the radial aspect of the metacarpal heads. Other organs can be affected by iron deposition, most commonly the brain, liver, pancreas and spleen.

6. A 60 year old woman presents to her GP with renal colic and hypercalcaemia. She has the following findings on plain film: subperiosteal bone resorption of the proximal phalanges of the hands, chondrocalcinosis of the articular cartilage at the knee joints, and a well-defined lytic lesion in the body of the mandible. The most likely unifying diagnosis is:
- a. Parathyroid adenoma
  - b. Parathyroid carcinoma
  - c. Renal osteodystrophy
  - d. Osteomalacia
  - e. Myeloma

**6. a. Parathyroid adenoma**

Parathyroid adenoma would be the most likely cause of primary hyperparathyroidism. Parathyroid carcinoma would produce a similar radiographic picture but is much less common. Brown tumours are seen in both primary and secondary hyperparathyroidism and are most common in the mandible, ribs and pelvis; they have a variable appearance on MRI and may simulate primary or secondary neoplasms.

35. A young man presents to his GP complaining of longstanding back pain. He says he has been diagnosed with a 'syndrome' in the past but cannot remember the details. Which of the following signs is more likely to suggest a diagnosis of homocystinuria than Marfan's syndrome?
- a. Arachnodactyly
  - ☒ b. Osteoporosis
  - c. Scoliosis of the spine
  - d. Autosomal dominant inheritance
  - e. Upward lens dislocation

**35. b. Osteoporosis**

Osteoporosis is a feature of homocystinuria and occurs in 75% of cases, often causing bowing and fracture of the long bones. The other features are all more suggestive of Marfan's syndrome. Although arachnodactyly does occur in homocystinuria (in 30% of cases), it occurs in 100% of people with Marfan's syndrome. Homocystinuria has an autosomal recessive mode of inheritance.

- 4 An otherwise well 84-year-old woman complains of left knee pain while away on an extended holiday with family and attends a local clinic for analgesia. As part of the work-up a radiograph is performed, which reveals chondrocalcinosis. She also remembers that she has been seen recently by a hospital endocrinologist but cannot remember any further details. What further underlying finding is likely?
- a Hypocalcaemia
  - b Hyperthyroidism
  - c Hyperparathyroidism
  - d Hyperkalaemia
  - e Hypopituitarism

4 Answer C: Hyperparathyroidism

Calcium pyrophosphate dihydrate crystal deposition (CPPD) is frequently associated with osteoarthritis (OA), but is distinguished by the presence of chondrocalcinosis. This term describes the imaging appearances of the presence of calcium in cartilage; for example menisci, triangular fibrocartilage of wrist. Chondrocalcinosis may have other causes, therefore technically is not synonymous with CPPD. Common associations of CPPD are: hyperparathyroidism, hypothyroidism, haemochromatosis, hypomagnesaemia and haemosiderosis.

- 27 An elderly lady fell onto her back and experienced severe back and buttock pain. Pelvic radiographs revealed marked osteopenia but no definite fracture. A bone scan was then performed, which showed an H-shaped pattern of increased uptake. Which bone is likely to be involved?
- a Sacrum
  - b Ilium
  - c Ischium
  - d Pubis
  - e Fifth lumbar vertebra

27 Answer A: Sacrum

Osteoporotic sacral insufficiency fractures have a classical H-shaped configuration.



- 66** A 40-year-old female presented feeling unwell and was found to have a raised serum calcium and alkaline phosphatase with a borderline low phosphate. She had several recent episodes of renal colic and felt generally weak. An X-ray of her pelvis showed a lytic lesion that was associated with an underlying endocrine abnormality. What is the likely imaging appearance?
- a Poorly defined central lesion with prominent periosteal reaction
  - b Poorly defined eccentric lesion with periosteal reaction
  - c Poorly defined central lesion with no periosteal reaction
  - d Well-defined cortical lesion with no periosteal reaction
  - e Well-defined central lesion with prominent periosteal reaction

**66** Answer D: Well-defined cortical lesion with no periosteal reaction

Brown tumours occur in hyperparathyroidism and are most common in the primary form. They are also known as osteoclastomas due to parathyroid hormone-stimulated osteoclastic activity. These tumours are eccentric/cortical and are usually solitary.

- 10** A 50-year-old man is known to have haemochromatosis and presents with pain in his hands. What distribution of involvement would be typical?
- a Interphalangeal joint of thumb
  - b Proximal interphalangeal joints of all fingers
  - c Distal interphalangeal joints of middle and ring fingers
  - d Metacarpophalangeal joints of index and middle fingers
  - e Metacarpophalangeal joints of ring and little fingers

**10** Answer E: Metacarpophalangeal joints of index and middle fingers

This classical distribution is distinctive although not every case will show the classical findings.



- 14 A 38-year-old female with a history of iron deficiency anaemia is seen in the Emergency Department following an alleged assault and has a skull radiograph to exclude the presence of a foreign body. What feature would be suggestive of a recurrence of her anaemia?
- a Narrowing of diploe
  - b Hair-on-end appearance of skull
  - c Osteopenia of zygoma
  - d Osteosclerosis of sphenoid
  - e Biconcave vertebrae

14 Answer B: Hair-on-end appearance of skull

Iron deficiency anaemia is caused by deficient iron stores at birth, dietary deficiency or excess blood loss for example, due to menstruation or from the gastrointestinal tract. Features are: widening of diploe, hair-on-end appearance of skull, osteoporosis in long bones and absence of facial bone involvement. Biconcave vertebrae occur in sickle cell anaemia.

- 7 Following acute on chronic back pain a 61-year-old female with a history of steroid use for inflammatory bowel disease is referred for further investigation. Her pelvic and lumbar spine radiographs are unremarkable. An MRI shows patchy low signal in the first sacral segment with loss of height and a radionuclide bone scan shows sacral uptake in an 'h-shaped configuration' with mild degenerative changes elsewhere. What is likely diagnosis based on the above findings?
- a Metastatic deposit
  - b Haemangioma
  - c Schmorl's node
  - d Osteoporotic collapse
  - e Insufficiency fracture

7 Answer E: Insufficiency fracture

The 'H' sign is usually diagnostic of a sacral insufficiency fracture. The sacrum can be difficult to assess on conventional radiography and its absence does not exclude pathology.

- 20 A 46-year-old man presented with back pain and was noted to have marked calcification and loss of height of multiple intervertebral discs, predominately in the lumbar spine. A previous radiograph of his knee also demonstrated premature osteoarthritic changes with pronounced chondrocalcinosis. What is the most likely diagnosis?
- a Ankylosing spondylosis
  - b Ochronosis
  - c Hyperparathyroidism
  - d Wilson's disease
  - e Reiter's syndrome

20 Answer B: Ochronosis

Ochronosis or alkaptonuria is due to an inherited enzyme defect (homogentisic acid oxidase) and results in deposition of black pigment in cartilage. The features described are typical and affected individuals may also suffer from renal and cardiac failure.

- 39 A 33-year-old previously healthy man presented with a two-month history of bone pain and headaches. Blood tests show a serum calcium of 13.2 mg/dL with phosphate of 0.6 mM (reference ranges: calcium 8.5–10.5 mg/dL, phosphate 0.8–1.5 mM). Which of the following bone lesions is most frequently associated with these findings?
- a Osteitis fibrosa cystica
  - b Fibrous dysplasia
  - c Osteochondroma
  - d Paget's disease of bone
  - e Giant cell tumour

39 Answer A: Osteitis fibrosa cystica

Osteitis fibrosa cystica is caused by an excess of PTH causing increased osteoclastic resorption of bone. It is seen in people with hyperparathyroidism and can present with headaches and bone pain. Fibrous dysplasia, osteochondroma, Paget's disease of bone and giant cell tumour are not associated with disorders of calcium metabolism.

- 64 A gentleman presented with early onset arthritis and generalised osteoporosis. His hands were worst affected with enlargement of the metacarpal head and loss of joint space particularly in the second and third metacarpophalangeal joints. Which malignancy is he at highest risk of?
- a Non-small-cell lung cancer
  - b Testicular teratoma
  - c Hepatoma
  - d Colonic carcinoma
  - e Melanoma

64 Answer C: Hepatoma

The patient has haemochromatosis and cirrhosis is common. Cardiac failure is also a common cause of death. Females present later if at all due to the protective effect of menstruation.

14. A 60-year-old man presents to the A&E department with acute onset lower back pain following a relatively minor fall. A plain film reveals a collapse of the L4 vertebral body against a background of osteopenia. He has a history of renal cell carcinoma and the clinical team request an MRI to 'rule out metastatic disease'. Which of the following features would most suggest a malignant rather than a benign cause for a vertebral compression fracture?
- A. Isointense signal to adjacent vertebral bodies on T2WI.
  - B. A band-like area of low signal adjacent to the fractured end-plate on T1WI.
  - C. High signal intensity adjacent to the vertebral endplate on STIR imaging.
  - D. Retropulsion of a posterior fragment into the spinal canal.
  - E. A convex bulge involving the whole of the posterior cortex of the vertebral body.

**14. E.** A convex bulge involving the whole of the posterior cortex of the vertebral body.

The others are more in keeping with benign compression fractures. Retropulsion of a posterior fragment into the spinal canal is a highly specific (100%) finding of benign compression fracture, but has a sensitivity of only 16%. Other features in keeping with malignant compression fractures are complete replacement of normal marrow with low signal on T1WI, involvement of the pedicles, and the presence of an epidural and/or paraspinal soft-tissue mass. The presence of an epidural mass is said to have 80% sensitivity and 100% specificity for malignant fractures. Convex bulging of the posterior cortex of the vertebra and involvement of the pedicle have respective sensitivities and specificities of 70% and 94%, and 80% and 94%. Beware that compression fractures due to multiple myeloma only rarely show MRI features of malignant fracture and this diagnosis should be included in the differential of a non-traumatic, benign-appearing vertebral compression fracture.

**47. A patient presents to their GP with a complex history of acute episodes of severe tender inflamed joints, in particular around the knee. At present the patient has joint stiffness which is most pronounced in the evenings and mild joint pain. The patient has a past medical history of hypothyroidism. A plain film is requested which shows chondrocalcinosis and moderate degenerative change in the lateral tibiofemoral compartment and the patellofemoral compartment. Regarding CPPD disease, which of the following statements is the most appropriate?**

- A. The presence of chondrocalcinosis indicates a radiological diagnosis of pseudogout.
- B. Pseudogout syndrome is the most common means of presentation for this disease.
- C. Disproportionate involvement of the patellofemoral joint is the most frequently seen radiographic finding.
- D. The presence of crystals displaying positive birefringence at polarized light microscopy allows for the definitive diagnosis of pyrophosphate arthropathy.
- E. The presence of hypothyroidism is associated with the diagnosis.

**47. E.** The presence of hypothyroidism is associated with the diagnosis.

Disorders associated with CPPD are the four Hs: hyperparathyroidism, haemochromatosis, hypothyroidism, and hypomagnesaemia. Use of nomenclature in this disorder is confused. Pseudogout is the clinical presentation of an acutely inflamed joint due to calcium pyrophosphate crystal deposition, and as such is not a radiological diagnosis. Pseudogout syndrome is the dominant feature in only 10–20% of cases of CPPD. Another 10–20% of cases are asymptomatic, whilst most present with symptoms identical to OA, with occasional flares. Disproportionate involvement of the patellofemoral joint is a characteristic feature, but is only occasionally seen. Pyrophosphate arthropathy is a description of the pattern of disease present due to crystal deposition, and as such is not a diagnosis made by analysis of joint aspirate.



**49. A 76-year-old man presents with hip and pelvic pain. He has a past history of renal cell carcinoma treated by radiofrequency ablation, and has been treated on multiple occasions with heparin for thromboembolic disease. Plain films are non-contributory but a  $^{99m}\text{Tc}$  bone scan reveals increased thoracic kyphosis and increased uptake in the body and bilateral alae of the sacrum in an H configuration. What is the most likely diagnosis?**

- A. Brown tumour.
- B. Multiple myeloma.
- C. Metastasis from renal cell carcinoma.
- D. Chordoma.
- E. Insufficiency fractures.

**49. E. Insufficiency fractures.**

This patient has developed osteoporosis due to heparin administration (and with age). This has resulted in thoracic kyphosis and the 'H' sign of increased uptake within the sacral body and alae, which is classical of insufficiency fractures of the sacrum. Often there will have been relatively minor trauma that will not be reported by the patient, and there may be associated pubic rami fractures. Radiotherapy to the area (e.g. in gynaecological malignancy) is another predisposing factor.

Multiple myeloma, metastases from renal cell carcinoma, and chordoma are typically osteolytic and result in osteopenia at isotope bone scan (IBS), although the investigation has poor sensitivity for myeloma. Brown tumours do cause increased uptake on IBS, but we are not given a history of renal failure or hyperparathyroidism to explain their presence. There is no history given to suggest infection.

Bone metastases which cause an increased uptake on IBS are breast, prostate, lymphoma, pulmonary carcinoid, mucinous GI, and bladder tumours. Renal cell carcinoma, thyroid, and melanoma typically cause photopenia.

**55. A 10-year-old male involved in an RTA is brought to the A&E department with a history of severe right thigh pain. Plain radiograph demonstrates a transverse fracture in the mid-diaphysis of the femur. Incidental note is made of bone osteopenia and undertubulation of the femur with metaphyseal flaring producing Erlenmeyer flask deformity and coxa magna related to previous avascular necrosis of the femoral head. What is the underlying bone disease?**

- A. Pyle's disease.
- B. Osteopetrosis.
- C. Gaucher's disease.
- D. Fibrous dysplasia.
- E. Ollier's disease.

**55. C. Gaucher's disease.**

All these conditions cause Erlenmeyer flask deformity and are associated with pathological fractures. However, the history of previous avascular necrosis of femoral head suggests Gaucher's disease. Sickle-cell disease (SCD) may also cause all the above bone changes.

Gaucher's disease is a rare familial metabolic disorder caused by deficiency of the enzyme  $\beta$ -glucocerebrosidase. This leads to accumulation of glucocerebroside in reticuloendothelial cells (macrophages) of the liver, spleen, and bone marrow.

The imaging findings include delayed growth, osteopenia, Erlenmeyer flask deformity, metaphyseal notching of humeri, bone infarction/avascular necrosis, and pathological fractures. Diffuse marrow replacement with low signal on T1WI is noted on MRI. Visceral manifestations include hepato-splenomegaly and reticulonodular interstitial lung disease.

**59. A 34-year-old man is admitted with sudden onset chest pain described as tearing in nature. Clinical examination reveals a diastolic murmur consistent with aortic regurgitation. Subsequent chest CT confirms ascending aortic dissection. He has a past medical history of spontaneous pneumothorax. Despite a negative family history, an underlying diagnosis of Marfan syndrome is suspected. Which of the following musculoskeletal manifestations is required for this diagnosis to be made?**

- A. Joint hypermobility.
- B. Pectus excavatum of moderate severity.
- C. Reduced upper-to-lower segment ratio.
- D. High arched palate.
- E. Malar hypoplasia.



**59. C. Reduced upper-to-lower segment ratio.**

Marfan syndrome is an autosomal dominant multisystem connective tissue disorder, but approximately 25% are sporadic mutations. Mutation of the fibrillin-1 gene is the underlying genetic abnormality. There is a broad phenotype expression, although diagnosis can be made clinically based on the presence of major and minor features as per the Ghent classification system. In the absence of a family history, the presence of two major criteria in two different organ systems and a minor criterion in a third system supports a diagnosis of Marfan syndrome.

In this case, dissection of the ascending aorta is a major cardiovascular criterion and spontaneous pneumothorax a minor pulmonary system criterion. Of the musculoskeletal manifestations, reduced upper-to-lower segment ratio is a major criterion, the remaining options are all minor criteria. Other musculoskeletal system major criteria include scoliosis with a curvature greater than 20°, pectus carinatum, pectus excavatum requiring surgery, acetabular protrusion, and medial displacement of the medial malleolus causing pes planus.

**61. A patient is referred from the dialysis unit with a history of joint and muscular pain. In particular they complain of bilateral hand pain and hip pain. The plain films of both hands show a loss of distinction of the radial aspect of the phalanges of the index and middle fingers. There is an area of para-articular soft tissue calcification noted adjacent to the middle finger metacarpal of the right hand. The pelvic x-ray is distinctly abnormal. There is a large expansile lucent lesion in the right iliac bone, which has a narrow zone of transition and no evidence of internal matrix. The bony definition of the rest of the pelvic bone reveals a coarsened trabecular pattern, but no evidence of expansion of the bones. There are multiple small linear lucencies noted along the medial aspect of the femurs bilaterally, which demonstrate a periosteal reaction. What condition do you think this patient has?**

- A. Primary hyperparathyroidism.
- B. Secondary hyperparathyroidism.
- C. Paget's disease.
- D. Osteomalacia.
- E. Renal osteodystrophy.

**61. E. Renal osteodystrophy.**

The first important observation to note is the referral route. A patient from the dialysis unit is going to have renal failure, thereby excluding tertiary hyperparathyroidism and making primary less likely. This leaves Paget's disease, osteomalacia, and renal osteodystrophy. The patient clearly has features of both hyperparathyroidism (subperiosteal resorption, brown tumour in iliac bone) and osteomalacia (Looser's zones), giving the diagnosis of renal osteodystrophy, which has features of both. Another feature of renal osteodystrophy is the soft-tissue calcification noted in the hand. The Looser's zones are small stress fractures on the load-bearing aspect of a bone, caused by osteomalacia. This contrasts with the stress fractures seen on the tensile aspect of bones (i.e. lateral aspect of femur) seen in Paget's disease and fibrous dysplasia. Whilst Brown tumours are more closely associated with primary hyperparathyroidism, the majority actually occur in secondary hyperparathyroidism as this disease is much more prevalent.

**64. A 57-year-old female patient with a history of multiple myeloma is referred for imaging due to a history of arthralgia primarily affecting the hands. The patient describes early morning stiffness that eases through the day. The clinicians report a finding of synovitis clinically. Blood results have revealed a raised ESR. Hand x-rays are carried out which reveal sharply defined intra-articular marginal erosions at the MCP joints of the index and middle fingers bilaterally. The joint spaces are well preserved. There are also well-marginated subchondral cysts noted in the carpal bones, again with joint space preservation. Soft tissue nodules are noted around the wrist joints, which are not calcified. There is no evidence of juxta-articular osteopenia. No osteophytes are noted. What diagnosis is most strongly suggested by these findings?**

- A. Gout.
- B. CPPD.
- C. RA.
- D. Amyloidosis.
- E. Wilson's disease.



#### 64. D. Amyloidosis.

There are a lot of conditions that are capable of mimicking RA. In these cases a few key features can help reach a diagnosis. The classic finding in gout is of non-marginal erosions, as opposed to those described. Nevertheless, marginal erosions can occur with gout. An RA-type picture in the presence of non-marginal erosions or calcified soft-tissue nodules (tophi) should suggest this diagnosis. CPPD gives a more productive pattern of arthritis, such as seen with OA, affecting the radio-carpal joint. Thus, it is often suspected when the appearance is of OA with a 'funny distribution'. Amyloidosis is suggested first by the history of MM. Involvement of the hands is more commonly seen in amyloid secondary to prolonged dialysis, but can be seen when the amyloid is secondary to MM, when the wrists are often affected. Amyloid can closely resemble RA in its distribution and the pattern of erosions. However, three important features can help differentiate: amyloidosis classically preserves the joint space, is not usually associated with periarticular osteopenia, and amyloidosis causes well-demarcated subchondral cyst formation in excess to that expected from the degree of joint disease.

**74. You are reviewing the x-rays of a child that are stored in your department's museum. Sequential radiographs have been taken as the child has aged and the appearances have become more pronounced with time. The child has a form of dwarfism. On the CXR you notice 'oar-shaped' ribs. The metacarpals are short and wide, but narrow proximally, giving a fan-like appearance. The patient has a J-shaped sella turcica. The iliac wings are wide, but the iliac bones narrow inferiorly. On the lateral lumbar spine, the vertebra have central anterior beaks. A clinical vignette mentions that the patient was not intellectually impaired. What condition does the patient probably have?**

- A. Campomelic dysplasia.
- B. Niemann–Pick disease.
- C. Morquio syndrome.
- D. Achondroplasia.
- E. Hurler's syndrome.

#### 74. C. Morquio syndrome.

The constellation of skeletal manifestations describes the characteristic appearance of dyostosis multiplex. This pattern of skeletal abnormalities is seen with the mucopolysaccharidoses (MPS), although it can also be seen with other storage disorders. With the exception of Hurler's syndrome, where the manifestations are present at 1 year of age, the skeletal manifestations progress as the patients get older. Hurler's and Morquio's are the most common of the MPS conditions. Amongst the MPS conditions, Morquio's stands out as a favourite for single best answer (SBA) and viva questions as it is the only MPS where the patient is not intellectually impaired. It also displays a central anterior vertebral body beak, whereas the other conditions have an anterior beak in the lower third of the vertebral body.

The differences with achondroplasia are the progression with age and the pelvic shape. The pelvis in achondroplasia has widened iliac wings, with horizontal acetabular roofs and a narrow inlet, giving the classic 'champagne glass' appearance. The anterior beak in achondroplasia is also in the lower third of the vertebral body.

- occurs also in Paget  
② fibrous dysplasia  
③ osteogenesis imperfecta
- 4 A stress fracture in which of the following areas would be most indicative of a pseudofracture (Looser's zone) of osteomalacia? *usually bilaterally & symmetrical and at right angle to the cortical margin*
- (a) Axillary margin of the scapula
  - (b) Distal 1/3 ulna *→ proximal*
  - (c) Greater trochanter of the femur *lesser trochanter*
  - (d) Lateral femoral neck *medial*
  - (e) Proximal 1/3 radius *distal*

#### 4 (a)

Pseudofractures (Looser's zones) are insufficiency stress fractures with poor healing due to mineral deficiency. These are classically associated with osteomalacia, but can also be due to Paget's disease, osteogenesis imperfecta, or fibrous dysplasia. The fractures are typically bilateral and symmetrical and are at right angles to the cortical margin. Other common locations include distal 1/3 radius, proximal 1/3 ulna, lesser trochanter, medial femoral neck, ischial tuberosity, clavicle, long bones of the feet and hands.

- 50 A 3 month old infant presents with tender, hard swellings over a number of bones. Radiographs reveal a cortical hyperostosis and marked, diffuse, symmetrical periosteal reaction of the clavicles, ribs and mandible.

Which of the following is the most likely diagnosis?

- (a) Rickets
- (b) Caffey's disease *= infantile cortical hyperostosis*
- (c) Hypothyroidism
- (d) Scurvy
- (e) Ulcerative colitis

50 (b)

The appearances are typical of Caffey's disease, also known as infantile cortical hyperostosis. Scurvy and rickets are unlikely to produce this picture in those < 6 months old.

- 14 A 32 year old woman undergoes a CXR after developing a cough. The CXR is unremarkable except for bilateral superior rib notching affecting multiple ribs.

Which of the following is least likely?

- (a) Hypoparathyroidism
- (b) Rheumatoid arthritis
- (c) Scleroderma
- (d) Systemic lupus erythematosus
- (e) Marfan's syndrome

14 (a)

Hyperparathyroidism is a cause of both superior and inferior rib notching, but not hypoparathyroidism.

- 35 A 28 year old man undergoes a CXR for occupational purposes. The lung parenchyma is clear, but the ribs are noted to be diffusely sclerotic.**

**Which of the following does not cause bone sclerosis?**

- (a) Fibrous dysplasia
- (b) Acromegaly
- (c) Mastocytosis
- (d) Tuberous sclerosis
- (e) Fluorosis

**35 (b)**

Acromegaly, along with Cushing's disease and scurvy are acquired causes of lucent ribs. Other causes of dense ribs include osteopetrosis, subperiosteal rib resection, chronic infection and trauma.

- 56 A 50 year old man presents with gradual onset pain in multiple joints. Radiographs and MRI examinations show bilateral olecranon bursal effusions along with well defined, homogeneous, enhancing soft tissue masses which are isointense to muscle on T1W and hypointense on T2W which involve the wrist, ankle and knee joints.**

**What is the likeliest diagnosis?**

- (a) Rheumatoid arthritis
- (b) Gout
- (c) Pseudogout
- (d) Psoriasis
- (e) Amyloidosis

**56 (b)**

Gout is polyarticular in 10% of cases. The soft tissue components have characteristic appearances and may calcify. Bilateral olecranon bursal effusions are considered pathognomonic.



- 72** A 56 year old woman is found to have uniform osteopaenia, cortical thinning, acetabular protrusion, indistinct trabeculae and pseudofractures involving the femoral necks on a pelvic radiograph.

**Which of the following is least likely to cause these appearances?**

- (a) Paraneoplastic syndrome
- (b) Biliary disease
- (c) Phenobarbitone
- (d) Dietary phosphorous deficiency
- (e) Renal tubular acidosis

**72 (a)**

These are the classic radiographic findings of osteomalacia. Other causes relate to interference with vitamin D metabolism such as previous partial gastrectomy, or decreased calcium deposition in bone such as in bisphosphonate treatment in Paget's disease.

38) A 49-year-old woman presents to her general practitioner with a history of mild midfoot pain exacerbated by walking and wearing tight shoes. Ultrasound scan demonstrates a hypoechoic, 7 mm, rounded lesion lying in the third tarsal interspace. The lesion is poorly demonstrated on MRI, returning intermediate T1 and low T2 signal. Which of the following conditions best explains these findings?

- a. tendon sheath ganglion
- b. tendon sheath giant cell tumour
- c. synovial cyst
- d. Morton's neuroma
- e. paraganglioma

38) d. \*\*

Morton's or interdigital neuroma is a benign lesion consisting of perineural fibrosis that entraps a plantar digital nerve. It is frequently asymptomatic and women represent 80% of cases. Clinical presentation is with foot pain exacerbated by walking, and symptomatic lesions are surgically excised. They are not usually demonstrated on plain radiography and are poorly seen on MRI, returning intermediate T1 and low T2 signal (similar to surrounding tissues). Typical ultrasound appearances are of a hypoechoic rounded lesion, larger in the axial than the sagittal plane. Ganglia and cysts would return high signal on T2W images, and pathology arising from the tendon sheath itself can also show high signal. Giant cell tumours are usually painless.

59) A middle-aged woman, known to suffer from polyostotic fibrous dysplasia, presents with a palpable, 3 cm, soft-tissue mass in the upper left thigh. MRI shows a relatively homogeneous, smooth, well-defined lesion located in an atrophic quadriceps muscle, which returns low signal on T1W images and high signal on T2W images. Following administration of intravenous gadolinium, the lesion shows moderately intense heterogeneous enhancement. What is the most likely pathological nature of the soft-tissue lesion?

- a. soft-tissue myxoma *(association fibrous dysplasia = Mazabraud's syndrome)*
- b. malignant fibrous histiocytoma
- c. soft-tissue cavernous haemangioma
- d. multiple lipomatosis
- e. rhabdomyosarcoma

59) a. \*\*\*\*

The association of fibrous dysplasia and soft-tissue myxoma is well established and is commonly termed Mazabraud's syndrome. The key is identifying the relationship between the bone and soft-tissue pathology, with the osseous features of fibrous dysplasia usually preceding the formation of a soft-tissue mass. The condition is non-familial and more commonly affects women, the thigh being the most common location. Typical MRI appearances are of a well-defined lesion with signal intensity similar to water, and often a fat rind or adjacent muscle high signal on T2W images is seen. Although uncommon, there have been reported cases of malignant change into osteosarcoma.

95) A 70-year-old man attends a 6-week follow-up appointment after cemented total hip arthroplasty, complaining of a poor range of motion. Radiographs taken during the appointment show small areas of pericapsular bone, and formation of small bony spurs at the acetabular margin. CT demonstrates these areas to have well-defined mineralization peripherally and indistinct centres. Which of the following processes are responsible?

- a. femoral component loosening
- b. heterotopic ossification
- c. periprosthetic fracture
- d. postoperative infection
- e. stress shielding

95) b. \*\*\*

Heterotopic ossification, also known as myositis ossificans, is a benign, self-limiting process of ossification occurring within skeletal muscle. Seventy-five per cent of cases are due to trauma (including iatrogenic trauma), with other causes including paralysis, burns, tetanus and intramuscular haematoma. The areas of new bone are surrounded by fibrotic connective tissue, which can be seen as a soft-tissue mass on MRI. Some heterotopic ossification is seen in half of all total hip replacements, with one-third considered clinically significant. It is classified radiographically according to the Brooker classification.

19. A 50 year old woman presents with a mass on the plantar aspect of her right foot. Ultrasound reveals a small oval-shaped lesion between the plantar portions of the metatarsal heads. MRI characteristics of the lesion are low-to-intermediate signal on T1 and low signal intensity on T2. Which of the following is the most likely diagnosis?

- a. Lipoma
- b. Morton's neuroma
- c. Plantar fibromatosis
- d. Giant cell tumour of the tendon sheath
- e. Ganglion cyst

19. **b. Morton's neuroma**

The description is that of a Morton's neuroma. This occurs most commonly in the third metatarsal space and less commonly in the second space. There is often an associated metatarsal bursitis which is a high signal on STIR imaging. Ultrasound is usually the first imaging modality; squeezing the metatarsal heads together during scanning will usually make the lesion more prominent.

41. A 20 year old student complains of a six-week history of pain and tenderness in his right thigh associated with a soft-tissue mass. There is no definite history of trauma. CT of the region shows a mass in the right distal femur with well-defined mineralisation at the periphery and a less distinct lucent centre. On plain film, there is faint calcification within the lesion and a radiolucent zone separating the lesion from bone. The most likely cause is:

- a. Tumoural calcinosis
- b. Osteomyelitis
- c. Myositis ossificans
- d. Parosteal sarcoma
- e. Osteosarcoma

41. **c. Myositis ossificans**

Often there is no distinct history of trauma, although this is the most common cause. It usually occurs in the large muscles of the extremities and in the early stages it can be difficult to distinguish from soft-tissue sarcomas. It is, however, separate from bone, unlike parosteal sarcoma and post-traumatic periostitis. This is a self-limiting condition, most commonly occurring in young athletic adults, with resorption occurring in approximately one year.

42. A 60 year old man is referred for an MRI of his left upper leg after noticing a slowly enlarging firm mass measuring approximately 7–8 cm in maximum diameter. The mass is located in the quadriceps muscle group and is causing cortical erosion of adjacent bone. There are poorly defined calcifications within it and MR shows a poorly defined lesion which is isointense to muscle on T1-weighted imaging and hyperintense on T2-weighted imaging. The most likely diagnosis is:

- a. Malignant fibrous histiocytoma
- b. Benign fibrous histiocytoma
- c. Liposarcoma
- d. Fibrosarcoma
- e. Elastofibroma



**42. a. Malignant fibrous histiocyoma**

Soft-tissue malignant fibrous histiocyoma is the most common primary malignant soft-tissue tumour of later adulthood. It is most commonly seen in the lower extremities. It has a metastatic rate of 42% and most commonly metastasises to the lung. Osseous malignant fibrous histiocyoma presents as a painful, tender, rapidly enlarging mass and most commonly arises in the metaphysis of long bones.

44. A 24 year old woman presents with a painless mass on the dorsal aspect of the right index finger measuring approximately  $1 \times 1$  cm. MRI shows a lobulated lesion which has low signal intensity on both T1- and T2-weighted imaging. Which of the following is the most likely diagnosis?

- a. Haemangioma
- b. Lipoma
- c. Ganglion cyst
- d. Giant cell tumour of the tendon sheath
- e. Neurilemmoma

**44. d. Giant cell tumour of the tendon sheath**

This is a benign lesion thought to represent an extra-articular form of pigmented villonodular hyperplasia. This is low signal on both T1- and T2-weighted imaging due to haemosiderin deposition. It most commonly affects the fingers and characteristically lies along a tendon sheath.

8 A 38-year-old man presented with a lump on the dorsal aspect of his hand that moved with the tendons on flexion and extension of his fingers. An X-ray and then MRI of this area were performed. What imaging findings might be expected?

- a A dense calcified mass
- b Low signal on T2-weighted images
- c High signal on T1-weighted images
- d No internal septations
- e Periosteal new bone formation

**8 Answer E: Periosteal new bone formation**

A soft-tissue ganglion is a cystic tumour-like lesion usually attached to a tendon sheath. It can present with a painful or a painless lump, most commonly over the hand, wrist or foot. The T1-weighted imaging characteristics are typically low to intermediate signal. Other features include: communication with joint, high signal on T2, internal septations, periosteal new bone formation. The natural history is spontaneous resolution although steroid injections may improve symptoms. Other types of ganglion include intraosseous and periosteal.

- 12** A 17-year-old boy presented to the Emergency Department five weeks after falling off his bike and hitting his thigh. Plain films showed some faint calcifications in the tissue adjacent to the femur and some simple periosteal reaction. A CT scan confirmed peripheral ossification. What is the most likely diagnosis?
- a** Osteosarcoma
  - b** Fibrosarcoma
  - c** Stress fracture
  - d** Chondrosarcoma
  - e** Myositis ossificans

**12 Answer E: Myositis ossificans**

This is also known as heterotopic ossification, pseudomalignant tumour of soft tissue and extraosseous localised non-neoplastic bone and cartilage formation. It is a benign solitary self-limiting ossifying soft tissue mass typically occurring within skeletal muscle. Direct trauma is the cause in 75%. The pathology is of a lesion surrounded by compressed fibrous connective tissue and surrounded by atrophic skeletal muscle. The symptoms include pain, tenderness and soft-tissue mass. It has a progressive natural history where it resolves spontaneously, which is reflected in its plain film and MR characteristics.

- 33** A 35-year-old horse rider complains of severe pain in her left thigh after riding a horse for the first time in many weeks. She has recently returned from a long business trip where she was unable to do any horse riding or other physical activity while away. The clinical team request an ultrasound scan to confirm the clinical diagnosis. What is the most likely abnormality?
- a Focus of low echogenicity within quadriceps tendon
  - b Discontinuity of sartorius tendon
  - c High echogenicity foci within gluteus maximus muscle belly
  - d Low attenuation within biceps femoris muscle belly
  - e Discontinuity of musculotendinous junction of adductor longus muscle

**33** Answer E: Discontinuity at musculotendinous junction of adductor longus muscle

Acute adductor strain is caused by forceful adduction of the thigh during an abduction movement. This sudden change in direction requires powerful contraction of the adductor muscles, which may tear to varying degrees depending on the adequacy of prior stretching and the force of the movement. Unless there is a complete tear, loss of function will not result, though there may be pain, swelling and ecchymoses on the anteromedial aspect of the thigh. Ultrasound may confirm the presence of a tear, which is often seen at the musculotendinous junction.

- 61** At what age does a haemangiopericytoma most commonly present?
- a 0–5 years
  - b 10–20 years
  - c 30–40 years
  - d 50–60 years
  - e Over 70 years

**61** Answer C: 30–40 years

Haemangiopericytoma is a rare tumour that usually occurs in the soft tissue of the thigh, pelvis or retroperitoneum and presents as a painless slow-growing mass. They may show locally aggressive behaviour.

- 50 A patient with a known area of fibrous dysplasia in their femur subsequently presented with a soft tissue mass in their thigh and an MRI was arranged.
- The mass was of low signal on T1- and high signal on T2-weighted images and a biopsy showed it to be a myxoma. What is the likely diagnosis?
- a Mazabraud's syndrome
  - b Ollier's syndrome
  - c Maffucci's syndrome
  - d Metastatic malignancy
  - e Gardner's syndrome

50 Answer A: Mazabraud's syndrome

Mazabraud's syndrome is the rare association of fibrous dysplasia with intramuscular myxoma and is an important differential for a soft-tissue mass with lytic bone lesions.

9. A 26-year-old woman presents with a 2-year history of an enlarging soft tissue mass in her left thumb adjacent to the interphalangeal joint. An x-ray of the left thumb shows a soft tissue swelling with a large well-defined erosion seen affecting the distal metaphysis of the proximal phalanx. There is no soft tissue calcification or evidence of arthropathy at the interphalangeal joint. A subsequent MRI scan shows a 3.5-cm well-defined soft-tissue mass, which is low signal on T1WI and enhances post administration of gadolinium. The lesion is low signal on T2WI and gradient echo (GE) imaging. What is the most likely diagnosis?
- A. Ganglion cyst.
  - B. Peripheral nerve sheath tumour.
  - C. Lipoma.
  - D. GCT of the tendon sheath.
  - E. Soft tissue haemangioma.

#### 9. D. GCT of the tendon sheath.

A GCT of the tendon sheath is a nodular form of PVNS. These tumours are intimately associated with a tendon sheath and are most commonly located in the hand. They usually manifest as a small slow-growing mass, with or without pain. Radiographs may show no abnormality or non-aggressive remodelling of the adjacent bone. These lesions are typically hypo- or iso-intense to muscle on T1WI and T2WI, owing to abundant collagen and haemosiderin, often with enhancement. This is similar to the findings of diffuse intra-articular PVNS, when the extent of haemosiderin deposition may cause hypointense nodules on T2WI and blooming artifact on gradient echo (GE) sequences. It must be stated that the degree of haemosiderin content may not always be enough to cause marked hypointensity on T2WI in GCT of the tendon sheath.

A ganglion cyst could occur in this location and be related to a tendon sheath, but on MRI it is typically hyperintense on T2WI secondary to its fluid component. There may be thin rim enhancement of the wall post administration of gadolinium. Peripheral nerve sheath tumours are typically hyperintense on T2WI with variable contrast enhancement. Lipomas are similar in signal characteristic to subcutaneous fat on MRI, i.e. hyperintense on both T1WI and T2WI. A soft-tissue haemangioma may contain phleboliths on plain radiographic imaging. On MRI, haemangiomas may be well circumscribed or have poorly defined margins, with varying amounts of increased T1WI signal owing to either reactive fat overgrowth or haemorrhage. Areas of slow flow are typically hyperintense on T2WI, while rapid flow can demonstrate a signal void on images obtained with a non-flow-sensitive sequence.

**21. A 54-year-old man presents with a swelling in his right popliteal fossa. A Baker's cyst is suspected clinically and an ultrasound scan is arranged. This confirms a complex cystic structure with debris. To help confirm this is a Baker's cyst, you look for a communication of this cyst with fluid at the posterior aspect of the knee joint between which two tendons?**

- A. Semitendinosus and lateral head of gastrocnemius.
- B. Semitendinosus and medial head of gastrocnemius.
- C. Semitendinosus and semimembranosus.
- D. Medial and lateral heads of gastrocnemius.
- E. Lateral head of gastrocnemius and semimembranosus.
- ✓ F. Medial head of gastrocnemius and semimembranosus.

**21. F.** Medial head of gastrocnemius and semimembranosus.

Identification of anechoic cysts communicating with fluid between the semimembranosus and gastrocnemius tendons confirms the diagnosis of Baker's cyst. It is important to perform further imaging if the mass in the posterior compartment lacks signs of communication with fluid between the semimembranosus and medial gastrocnemius tendons. If this is the case, there are other possibilities for the lesion, including meniscal cyst or even a myxoid sarcoma.



**38. A 39-year-old man presents with a gradually enlarging swelling in the upper lateral aspect of the right calf. He is also experiencing some numbness affecting the dorsum of his right foot. An ultrasound scan and subsequently an MRI scan demonstrate a well-defined, thinly septated cystic lesion intimately related to the proximal tibio-fibular joint and extending into the adjacent soft tissues. It measures approximately 4cm in maximum diameter. There is no enhancement of the soft tissue component post injection of gadolinium. What is the most likely diagnosis?**

- A. Parameniscal cyst.
- B. Bursitis.
- C. Focal tenosynovitis.
- D. Ganglion cyst.
- E. Chronic seroma.

**38. D. Ganglion cyst.**

What is being described is a ganglion cyst adjacent to the proximal tibiofibular joint that is causing a common peroneal nerve palsy. This is a well-recognized entity. Ganglion cysts can be uni- or multilocular. They occur predominately in peri-articular locations and may arise from tendon sheaths, joint capsules, bursae, or ligaments.

Although parameniscal cysts can extend inferiorly from the lateral knee joint margin, they typically show a communication with a meniscal tear. This is not described in the radiological findings and they are not typically centred at the level of the proximal tibiofibular joint.

Bursal distension can cause a multiloculated fluid collection. It can occur in typical locations around the knee joint, but not usually adjacent to the proximal tibiofibular joint. Examples include pes anserine bursitis, semi-membranosis-tibial collateral ligament bursitis, and pre-, supra-, and infrapatellar bursitis.

Focal tenosynovitis and chronic seroma do not particularly fit with the clinical and radiological findings.

**50. A 47-year-old man presents with a progressive history of pain, swelling, and reduced range of movement affecting his right knee. Symptoms have been ongoing for 2–3 years. Locking is noted on examination. Radiography of his knee reveals multiple intra-articular calcifications. A supra-patellar joint effusion is also present. The joint space is maintained. What is the most likely diagnosis?**

- A. Neuropathic arthropathy.
- B. Osteochondritis dissecans.
- C. Osteochondral fracture.
- D. PVNS.
- E. Synovial osteochondromatosis.

**50. E. Synovial osteochondromatosis.**

The primary form of this represents an uncommon benign neoplastic process with hyaline cartilage nodules in the subsynovial tissue of a joint, tendon sheath, or bursa. Secondary synovial chondromatosis is associated with joint abnormalities, such as mechanical or arthritic conditions, that cause intraarticular chondral bodies. The primary form of the disease predominantly affects men in the third to fifth decades. The knee is the most common site, but it is also seen in the hip, shoulder, elbow, and ankle; less commonly the MCP, IP, distal radioulnar, and acromioclavicular joints are involved. It can rarely involve extra-articular sites, the synovium about the tendons, or bursa. Clinical symptoms typically include pain, swelling, and restriction of the range of motion of the joint. Radiologic findings are frequently pathognomonic. Radiographs reveal multiple intraarticular calcifications (70–95% of cases) of similar size and shape distributed throughout the joint, with typical 'ring-and-arc' chondroid mineralization. Extrinsic erosion of bone is seen in 20–50% of cases. Juxtaarticular osteopenia is not typically apparent in synovial chondromatosis unless it is the result of disuse. CT is often diagnostic if the bodies are adequately mineralized and is particularly helpful for identifying characteristic ring-and-arc or punctate mineralization and the multiplicity of nodules in cases for which radiographic findings are normal or equivocal. Lack of mineralization of the bodies does occur in which cases MRI is very helpful to distinguish from, for example, PVNS or amyloid. The most common pattern on MRI (77% of cases) reveals low to intermediate signal intensity with T1WI and very high signal intensity with T2WI with hypointense calcifications.

**57. A 34-year-old man has a 3-month history of right knee pain. There is a remote history of previous right leg trauma. He has an x-ray of the right knee performed, which demonstrates a densely ossified mass immediately adjacent to the posterior cortex of the distal femur. You determine that the differential diagnosis is between post-traumatic myositis ossificans or a parosteal osteosarcoma. Which of the following features on plain x-ray is likely to be most helpful in distinguishing between these diagnoses?**

- A. Periosteal reaction in the adjacent bone.
- B. Presence of lucent areas in the lesion.
- C. Pattern of ossification in the lesion.
- D. Size of the lesion.
- E. Presence of lucent cleft between the lesion and adjacent bone.



**57. C.** Pattern of ossification in the lesion.

The pattern of ossification is likely to be the most helpful. In post-traumatic myositis ossificans, the ossification occurs classically first at the periphery, whereas in parosteal osteosarcoma, the ossification is diffuse, but predominantly central. Periosteal reaction is typically absent in both these lesions and both lesions may contain lucent areas on plain radiograph.

A lucent cleft between the mass and the bony cortex, representing periosteum, is characteristic in parosteal osteosarcoma, but frequently is not seen as the tumour envelops bone. A thick lucent zone separating myositis ossificans from an adjacent bony cortex is typical, but may not be seen on plain radiograph if the lesion is immediately juxta-cortical.

**75. A 35-year-old man presents with pain, swelling, and reduced movement of his knee. A plain film reveals a joint effusion, well-defined erosions with preservation of joint space, and normal bone mineralization. An MRI reveals, in addition, a mass in the region of the femoro-tibial joint space with low signal on T1WI and T2WI, and blooming artefact on GE imaging. What is the most likely diagnosis?**

- A. Synovial cell sarcoma.
- B. Regional migratory osteoporosis.
- C. Gout.
- D. Synovial chondromatosis.
- E. PVNS.

**75. E. PVNS.**

This is a monoarticular tumour-like proliferation of synovium that occurs in joints, bursae, and tendon sheaths. It may be focal or diffuse. It occurs most frequently in the knee (80% of cases), then the hip, ankle, shoulder, and elbow. The abnormal synovium is prone to haemorrhage, thus producing blooming artefact on GE sequences, secondary to haemosiderin deposition. In general the classic MRI appearance is variable low signal intensity on all sequences (T2WI signal being more variable due to fat, oedema, and blood products). Early changes involve a focal mass and joint effusion. Subsequently large erosions, synovial hypertrophy, and subchondral cysts may occur. Joint space is preserved until advanced disease is present and bone density is normal. After IV contrast at CT, PVNS shows variable enhancement, which can be striking. The differential diagnosis includes diseases causing recurrent haemarthroses, e.g. haemophilia and haemochromatosis (PVNS is monoarticular) as well as gout, amyloid, synovial chondromatosis, and tuberculosis.

Some 90% of synovial cell sarcomas do not originate from a joint. They are usually isointense to muscle on T1WI, with heterogeneous high-signal intensity on T2WI. Regional migratory osteoporosis would obviously involve loss of bone mineralization, as well as marrow oedema. Gout demonstrates typically 'rat's bite' para-articular erosions and soft-tissue calcification; when it involves the knee it tends to affect the patello-femoral compartment.

- 13 A calcified mass is seen on a plain radiograph of a young man's femur. The mass appears to be centred within the soft tissues of the thigh and the calcification is more prominent on the periphery of the mass. There is a radiolucent zone separating the lesion from the underlying bone, the cortex of which appears unaffected.

Which of the following is the most likely diagnosis?

- (a) Myositis ossificans *→ calcified periphery*
- (b) Parosteal osteosarcoma *→ calcified center*
- (c) Juxtacortical chondroma
- (d) Osteochondroma
- (e) Rhabdomyosarcoma

13 (a)

Myositis ossificans is a form of heterotopic bone formation within skeletal muscle, usually resulting from blunt trauma. Although parosteal osteosarcoma can have similar appearances, myositis ossificans typically has denser calcification in the periphery; osteosarcoma shows the reverse phenomenon, with denser calcification centrally. Juxtacortical chondroma typically scallops the underlying cortex. An osteochondroma is continuous with the underlying bone.

- 44 A 38-year-old woman presents with a palpable lump in her thigh. Plain films show a lobulated ossified mass lying posterior to the femur with a connection to the cortex. The centre of the lesion is denser than the periphery. MRI shows a large associated soft tissue component.

What is the likeliest diagnosis?

- (a) Myositis ossificans
- (b) Osteochondroma
- (c) Parosteal osteosarcoma *have the best prognosis of all osteosarcomas*
- (d) Periosteal osteosarcoma
- (e) Extrasosseous osteosarcoma

**44 (c)**

Parosteal osteosarcomas have the best prognosis of all osteosarcomas. If no stalk can be clearly identified they can be distinguished from myositis ossificans by the relative density of the centre of the ossified part of the lesion.

- 10 A gentleman presents with knee swelling, pain and stiffness. Plain radiographs and subsequent MR imaging were performed, and a diagnosis of pigmented villonodular synovitis is suspected.**

**Which of the following is not typical of this disease?**

- (a) Preservation of bone density
- (b) Synovial low signal intensity on gradient echo MR imaging
- (c) Well-defined erosions on both sides of the joint
- (d) Joint space narrowing early in the disease
- (e) Joint effusion

**10 (d)**

Pigmented villonodular synovitis is a proliferation of synovium that occurs in joints, bursae and tendon sheaths. The joint space is well preserved until late in the disease.

- 11 A patient presents with a painless, slow growing mass of the finger. On clinical and radiographic grounds, this is likely to be a giant cell tumour of the tendon sheath.**

**Regarding this condition, which of the following are incorrect?**

- (a) The lesion is typically non-calcified
- (b) The lesion is typically hypointense to muscle on T1W
- (c) Most lesions are associated with bony erosion
- (d) The lesion is not usually centred on a joint
- (e) The lesion is often painless



**11 (c)**

Giant cell tumours of the tendon sheath are histologically identical to pigmented villonodular synovitis. They usually occur in the hand, where they are the second most common benign tumour (the most common are ganglia). Only 10% of lesions are associated with bony erosion.

**41 A 35 year old woman presents with gradually progressive knee pain over several years with locking of the joint. Plain radiographs show multiple round, well defined calcified loose bodies in the joint with no osteoporosis, and widening of the joint space.**

**Which of the following is the likeliest diagnosis?**

- (a) Synovial osteochondromatosis
- (b) Pigmented villonodular synovitis
- (c) Lipoma arborescens
- (d) Synovial sarcoma
- (e) Osteochondritis dissecans

**41 (a)**

Cross sectional imaging shows a soft tissue mass of near water attenuation on CT containing calcifications, and a lobulated intra-articular mass which is isointense to muscle on T1W and hyperintense on T2W with foci of low signal intensity.

- 43 A 70 year old woman presents with a longstanding right sided painless swelling on her back. US shows a lesion with an array of linear strands against an echogenic background. MRI shows the lesion lies between the posterior chest wall and the inferomedial border of the scapula. It is well defined, has signal characteristics similar to surrounding skeletal muscle and has linear areas of high signal. It enhances heterogeneously after the administration of *i.v.* gadolinium.

**What is the likeliest diagnosis?**

- (a) Liposarcoma
- (b) Extra-abdominal desmoid
- (c) Metastasis
- (d) Elastofibroma
- (e) Lipoma

43 (d)

Elastofibroma is benign tumour forming as a reaction to mechanical friction most commonly seen in the subscapular area. Recent evidence suggests a genetic component. It is bilateral in 25%. Its site, presentation and imaging characteristics are usually typical, however, excision is still performed if there is any doubt with regards to malignant transformation.

- 65 An active 48 year old woman presents with pain and paresthesia between the 3rd and 4th metatarsals, which radiates to the toes. On examination, direct pressure between the metatarsal heads replicates the pain. On axial compression of the forefoot a 'click' is heard. MR shows a well demarcated 'teardrop-shaped' mass arising between the 3rd and the 4th metatarsal heads. The lesion is isointense to muscle on T1W and hypointense to fat on T2W, and enhances on T1W following *i.v.* gadolinium.

**What is the likely diagnosis?**

- (a) Freiberg's disease
- (b) Morton's neuroma
- (c) Rheumatoid nodule
- (d) Schwannoma
- (e) Tendon sheath ganglion

**65 (b)**

Morton's neuroma is actually a peri-neural fibrosis entrapping a plantar digital nerve. It is most commonly found in the 3rd/ 4th intermetatarsal space. The fibrous nature of the lesion accounts for the described MR findings. The 'click' which can be heard or palpated on examination is known as 'Mulder's' sign.

- 66** A 20 year old man presents with a swelling in his thigh. He recalls innocuous trauma at this site a few weeks earlier. Plain films suggest a soft tissue mass with peripheral calcification at the level of the mid femur with a radiolucent zone separating the lesion from cortex. MRI shows a heterogeneous, well defined soft tissue mass, isointense to muscle on T1W and hyperintense on T2W, with curvilinear peripheral areas of low signal intensity.

**Which of the following is the likeliest diagnosis?**

- (a) Myositis ossificans
- (b) Parosteal sarcoma
- (c) Tumoural calcinosis
- (d) Rhabdomyosarcoma
- (e) Chondrosarcoma

**66 (a)**

These are the typical findings of myositis ossificans. Although in the acute stages, it can be confused with other entities, as it matures and calcifies, it can be discriminated from osteosarcomas by the pattern of peripheral calcification and from parosteal sarcomas by the lack of a connecting stalk to the cortex.

**71** A 62 year old man presents with a history of a lump in his thigh which he feels has enlarged over several months. On plain films a soft tissue mass with punctuate calcification and adjacent cortical erosion is seen. At MRI the mass is confirmed to be in the soft tissues, is heterogeneous in signal intensity but is generally isointense to muscle on T1W and hyperintense on T2W.

**What is the likeliest diagnosis?**

- (a) Parosteal sarcoma
- (b) Liposarcoma
- (c) Lipoma
- (d) Malignant fibrous histiocyoma
- (e) Rhabdomyosarcoma

**71 (d)**

MFH is the commonest primary malignant soft tissue tumour of later life. It presents as a painless progressively enlarging mass. Calcification is seen in up to 20%. Cortical erosion of adjacent bone is a suggestive feature.





- 5) A young patient suffers a fractured femur and acetabulum in a road traffic collision and undergoes intramedullary nailing and plate-and-screw internal fixation of the acetabulum. He is well until 8 days postoperatively, when he develops acute shortness of breath and right-sided chest pain. A chest radiograph shows only a small right-sided pleural effusion. What is the most likely diagnosis?
- a. fat embolism
  - b. bronchial pneumonia
  - c. pulmonary embolism
  - d. pneumothorax
  - e. hyperventilation due to pain

5) c. \*\*

Pulmonary embolism is a common complication following immobility and major surgery, particularly orthopaedic surgery of the pelvis. It typically occurs 7–10 days post-surgery. Chest radiograph findings can be normal but include small effusion, collapse or consolidation, elevation of the hemidiaphragm, a prominent pulmonary artery and hypertransradiancy of the affected side (Westermark sign). Fat embolism is preceded by long bone injury in 90% of cases but usually occurs within 36 hours of the injury, and is much less common than pulmonary embolism from deep vein thrombosis even in the context of major trauma. Pneumonia and pneumothorax do of course occur in postoperative patients, but it would be reasonable to expect associated findings on the chest film. Hyperventilation should be a diagnosis of exclusion once other potentially serious causes have been excluded.

8) A middle-aged man with no significant medical history undergoes a radiograph of the pelvis for localized tenderness following a fall. Multiple longitudinally orientated, 2–10 mm rounded densities similar to cortical bone are seen throughout the cancellous bone, in a diffuse symmetrical pattern concentrated around the acetabulum. There is no fracture. What is the most likely diagnosis?

- a. osteopathia striata (Voorhoeve's disease) causes linear longitudinal
- b. osteopetrosis → generalised ↑ in bone density
- c. bone metastases
- d. melorheostosis flowing wax
- e. osteopoikilosis multiple bony islands (asymptomatic)

8) e. \*\*\*

Osteopoikilosis is a rare condition causing multiple enostoses (bone islands), which are asymptomatic and usually of no clinical significance. They represent deposits of normal cortical bone within the cancellous bone. Osteopathia striata (Voorhoeve's disease) is similar to osteopoikilosis in appearance and is usually asymptomatic, but it consists of linear longitudinal or sunburst striations rather than rounded densities. Osteopetrosis causes generalized increase in bone density, whereas melorheostosis is a cortical process giving a 'flowing wax' appearance, usually affecting only one side of the affected bone. While metastases are plausible, the patient would probably be symptomatic and have evidence or a history of a primary tumour.

16) MRI of the temporomandibular joint is performed for painful clicking, with no history of trauma. Which of the following internal derangements is the most likely underlying cause?

- a. torn intra-articular disc
- b. anteriorly displaced intra-articular disc
- c. hypertrophic/misshapen intra-articular disc
- d. erosive osteoarthritis
- e. insufficiency fracture of the condylar neck

16) b. \*\*\*\*

Abnormal disc position and morphology are the earliest and most sensitive signs of derangement, occurring three to five times more commonly in women and usually manifesting by the fourth decade. The cause is often not found but includes trauma, malocclusion, bruxism (teeth grinding) and primary osseous abnormalities. Disc deformity, if unchecked, leads to secondary osseous abnormality. Degenerative arthritis is typically erosive with flattening of the condylar head and anterior osteophytosis. The disc may become biconcave, thickened, folded or torn. On MRI of the joint, the position of the disc should be assessed first on closed-mouth sagittal T1W images. It may become displaced in any direction, with anterior being the most common. In the initial stages the disc may reduce on mouth closing, but with progression it becomes fixed in an anteriorly subluxed position. The temporomandibular joint can also be an involved site in rheumatoid arthritis.

17) In imaging of focal bone lesions in the appendicular skeleton, which of the following radiographic features is most likely to indicate an aggressive or malignant process?

- a. cortical expansion
- b. lytic process
- c. periosteal reaction
- d. multiple lesions
- e. wide zone of transition

17) e. \*\*

The zone of transition relates to the interface between the tumour margin and the host bone. It is an extremely important discriminator, particularly for lytic lesions. Lesions with a well-defined margin (and therefore narrow zone of transition) are described as geographic and are usually non-aggressive, whereas those with a wide zone of transition are termed 'permeative' and are often malignant or aggressive (such as



in osteomyelitis). Cortical expansion without destruction is seen in many benign or slow-growing conditions such as fibrous cortical defect and aneurysmal bone cyst. Many bone lesions, both benign and aggressive, are lytic. Periosteal reaction does not indicate an aggressive lesion as such, but the pattern of reaction can do so. Multiplicity is not an indicator of malignancy, as it can be seen in benign and self-limiting processes (such as multiple enchondromatosis and neurofibromatosis). Equally, a solitary lesion may be malignant.

- 21) Which of the following skeletal findings on plain radiographs is not typically associated with achondroplasia?
- a. short interpedicular distance
  - b. small foramen magnum
  - c. rhizomelia
  - d. horizontal acetabular roof
  - e. atlantoaxial instability

21) e. \*\*

Achondroplasia is the most commonly seen autosomal dominant rhizomelic dwarfism. Rhizomelia refers to relative shortening of the proximal compared with the distal portion of the limbs. Achondroplasia has widespread skeletal manifestations affecting the skull, chest, spine, pelvis and extremities. Intelligence and motor function are normal. The most significant complication is brain-stem or spinal cord compression due to spinal stenosis, which is caused by alignment abnormalities and decreased spinal canal size due to short pedicles with a reduced interpedicular distance. Atlantoaxial instability is defined as a predental space of 3 mm or more in adults and 5 mm or more in children, or where there is considerable change between flexion and extension. It is seen in inflammatory arthritides, in Down's and Morquio's syndromes, and with retropharyngeal abscess in a child.



28) Osteoporosis circumscripta – well-defined geographic lytic lesions in the skull – represents the early stages of which condition?

- a. Paget's disease
- b. hyperparathyroidism
- c. multiple myeloma
- d. senile osteoporosis
- e. sickle cell disease

28) a. \*\*

Paget's disease is a common progressive disorder of osteoclasts and osteoblasts resulting in bone remodelling. It is usually polyostotic and asymmetrical, and affects 10% of those aged over 80. Osteoporosis circumscripta is seen in the initial phase of Paget's disease, which is characterized by an aggressive, predominantly lytic process with intense osteoclastic activity causing bone resorption. Bone marrow is replaced by fibrous tissue with large vascular channels. Geographic osteoporosis is seen in the skull and long bones, where the characteristic feature is a flame-shaped radiolucency beginning in a subarticular location and progressing into the diaphysis. The disease then progresses through a mixed phase to a quiescent inactive late stage where bone turnover is decreased. The skull is involved in 29–65% of cases, most commonly the anterior calvarium.

29) On lateral radiographs of the thoracolumbar spine, a central anterior beak of the vertebral bodies is most likely to suggest which of the following conditions?

- a. Scheuermann's disease *no beak*
- b. Morquio's syndrome
- c. Hurler's syndrome *inferior beak*
- d. Down's syndrome *inferior beak*
- e. achondroplasia *inferior beak*

29) b. \*\*\*

Morquio's syndrome is type IV and the most common of the mucopolysaccharidoses, a family of inherited disorders of metabolism. A central vertebral beak is relatively specific for the condition. Other spinal manifestations include odontoid hypoplasia with atlantoaxial subluxation (which can be life threatening), platyspondyly, ovoid vertebral bodies, widened intervertebral disc space and exaggeration of the normal lumbar lordosis. Other skeletal findings include dwarfism, as well as skull, face and appendicular abnormalities. Hurler's syndrome belongs to the same family of disorders but has an inferior vertebral

beak, which is also seen in achondroplasia and Down's syndrome. Scheuermann's disease does not show vertebral beaking.

40) On plain radiographs, which of the following is the most specific indicator of prosthetic loosening following total hip replacement?

- a. sclerosis at the tip of the femoral component
- b. 3 mm, lucent line at the cement/prosthesis interface
- c. heterotopic bone formation
- d. periprosthetic fracture
- e. femoral periosteal reaction

Periosteal reaction and sclerosis can be normal findings particularly in uncemented prostheses.

40) b. \*

The artefact created by metallic prostheses on CT and MRI means that plain radiography has an important role in the evaluation of post-operative arthroplasty joints. Cemented prostheses may normally show a 1–2 mm lucent line at cement interfaces, but definite loosening is diagnosed with progressive widening of this zone. Other specific indicators of loosening in both cemented and uncemented prostheses include migration of components or a new abnormality of alignment. Periosteal reaction and sclerosis can be normal findings, particularly in uncemented prostheses. Serial imaging is often required to confirm the diagnosis of loosening.

46) On plain radiographs of the hands, hyperflexion of the proximal interphalangeal joint of the index finger, with hyperextension of the distal interphalangeal joint of the same finger, describes which deformity?

- a. swan-neck
- b. Boutonnière
- c. mallet finger
- d. baseball finger
- e. Z-deformity

The same = limited flexion at the proximal interphalangeal joint and hyperextension at the distal interphalangeal joint.  
Boutonnière of thumb

46) b. \*\*

The Boutonnière deformity is commonly caused by injury or inflammatory conditions such as rheumatoid arthritis, and more commonly affects the index than middle fingers. It consists of four stages. Stages 1 and 2 are mild and moderate, passively correctable extension lag, whereas stages 3 and 4 are mild and advanced flexion contractures. The proximal flexion deformity is due to disruption of the central slip of the extensor tendon, with the proximal phalanx herniating through the defect and the lateral slips lying on either side. The position of the proximal phalanx stretches the lateral slips and pulls the distal phalanx into extension. Swan-neck deformity has similar causes but the opposite configuration, with extension at the proximal interphalangeal joint and flexion distally. Mallet (or baseball) fingers have a passively correctable flexion deformity of the distal interphalangeal joint caused by avulsion of the extensor digitorum tendon by a hyperflexion injury. Z-deformity is the name given to a Boutonnière-type deformity seen in the thumb.

51) At which of the following skeletal locations does avascular osteonecrosis typically only occur in the presence of an associated fracture?

- a. medial tibial condyle *Blount's disease*
- b. second metatarsal head *Freiberg*
- c. lunate *Kienbock*
- d. femoral head *Pertuis*
- e. proximal scaphoid pole



51) e. \*

Osteonecrosis may be caused by two mechanisms: interruption of arterial supply, and intra- or extra-osseous venous insufficiency. Interruption of vascular supply is usually associated with a fracture, as seen in the proximal scaphoid following waist fractures. Femoral head osteonecrosis can occur with subcapital fractures, or without fracture as in Legg–Calvé–Perthes disease. Other common locations that may develop osteonecrosis without overt fracture include the medial tibial condyle (Blount's disease), metatarsal head (Freiberg's infraction) and the lunate (Kienbock's disease). Radiographic findings often lag several months behind the injury or onset of symptoms, and MR is the most sensitive imaging modality. Radiographic signs include focal radiolucencies, sclerosis, bone collapse and loss of joint space.

54) A 30-year-old woman undergoes plain radiographic imaging of the hand for a palpable, painful hard lump on the dorsum. Plain radiographs show a well-defined bony mass applied closely to the diaphysis of the second metacarpal. CT shows a wide-based pedunculated lesion with a perpendicular orientation to the diaphysis, no cartilage cap and a matrix of mature trabeculated bone. What is the most likely diagnosis?

- a. osteochondroma
- b. multiple osteocartilaginous exostoses
- c. bizarre paraosteal osteochondromatous proliferation
- d. Codman's tumour
- e. dysplasia epiphysealis hemimelica



54) c. \*\*\*\*\*

Bizarre paraosteal osteochondromatous proliferation (also known as Nora's lesion) is a rare condition usually seen in adults in the third and fourth decades of life. Osteochondroma-like lesions are seen most commonly at the proximal and middle phalanges, followed by the metacarpals and metatarsals. A relationship to trauma has been suggested but not proven. Other locations that may be affected include the long bones (especially those of the upper extremity), skull and jaw. It is thought to be a similar process to that which gives rise to lesions in myositis ossificans, reactive periostitis and subungual exostosis. On plain radiographs, a well-defined bony mass is seen attached to the surface of the parent bone. Features differentiating this from osteochondroma are the absence of angulation away from the nearby physis and a wide base.

56) Bilateral hand radiographs performed in a 70-year-old man for painful and stiff joints reveal a symmetrical periosteal reaction involving the metacarpals, increased soft tissue of the fingertips, and an increase in the longitudinal curvature of the fingernails. Which additional imaging investigation is most appropriate?

- a. CT of the hands
- b. MRI of the hands
- c. isotope bone scan
- ☒ d. radiograph of the chest
- e. radiographs of the shoulders

56) d. \*\*\*

Hypertrophic pulmonary osteoarthropathy (HPOA) is a clinical syndrome of osteitis of the long bones, arthritis and digital clubbing of the fingers and toes. It is most commonly associated with lung cancer (affecting 3-10% of patients) or other chronic pulmonary or pleural disease. The underlying mechanism has not been established with certainty, but autonomic nervous or endocrine stimulation by tumours

is postulated, with hormones such as oestrogen, adrenocorticotrophic hormone and growth hormone implicated. In patients presenting with HPOA, approximately 80% have an underlying lung cancer, 10% a pleural tumour and 5% another intrathoracic malignancy. Other causes include chronic, suppurative, pulmonary inflammatory disease and congenital cyanotic heart disease. Typical radiographic appearances are of a lamellar periosteal reaction affecting the diaphyseal regions of the long bones, particularly the dorsal and medial aspects. Bone symptoms and radiographic signs frequently regress following treatment of the underlying cause.

65) A 40-year-old woman presents to the emergency department with a painful, stiff shoulder, 12 hours after undergoing arthrography of the same joint. She describes onset of symptoms 8 hours previously with progressive worsening. She feels otherwise well with a temperature of 37.3°C. There is no overt joint swelling or overlying erythema. What is the most likely cause?

- a. septic arthritis
- b. chemical synovitis
- c. joint haemarthrosis
- d. joint effusion
- e. allergic contrast reaction

65) b. \*\*

Post-arthrography pain due to sterile chemical synovitis is the most common complication of the procedure, typically beginning after 4 hours and peaking at 12 hours. Other, less common, immediate and short-term complications include allergic contrast reaction (rare in

intra-articular injections), introduction of infection and vasovagal reaction.

66) Which of the following features is not a recognized primary musculoskeletal manifestation of the CREST (calcinosis, Raynaud's phenomenon, oesophageal involvement, sclerodactyly and telangiectasia) syndrome?

- a. digital oedema
- b. calcinosis
- c. acro-osteolysis
- d. osteoporosis
- e. joint erosions

66) d. \*\*\*

CREST syndrome represents the limited form of the autoimmune connective tissue disorder scleroderma. Five-year survival rate is 50–67%. The two other types of scleroderma are generalized (also called systemic sclerosis) and localized (morphoea). Common findings are digital soft-tissue oedema with sclerodactyly (tapered soft tissues), acro-osteolysis (autoamputation) and calcinosis. There may be associated arthritis that shows erosions (also seen in the ribs) or terminal phalanx resorption, with joint space narrowing a late sign. Osteoporosis is not usually a feature except in the context of disuse.

68) Which of the following is not a recognized cause of myeloid hyperplasia (red marrow reactivation/reconversion) in a 50-year-old adult?

- a. sickle cell disease
- b. smoking
- c. chemotherapy
- d. long-distance running
- e. Gaucher's disease



68) e. \*\*\*

Marrow reconversion is the repopulation of yellow (fatty) marrow with haematopoietic cells, reconvertng the fatty marrow to red marrow. This occurs when the haematopoietic capacity of the existing red marrow in an adult is insufficient. This can result from increased physiological requirement (long distance running), chronic anaemia (sickle cell disease) and chemotherapeutic treatment with granulocyte-macrophage colony-stimulating factor. The pattern of reconversion is predictable and it is the reverse of the age-related physiological conversion of red to yellow marrow. Reconversion begins in the axial skeleton and progresses distally through the appendicular skeleton, to end in the hands and feet. Knowledge and recognition of this pattern are important because neoplastic infiltration of adult yellow marrow in malignant disease may have similar MR appearances. However, malignant marrow replacement tends to have a more random

distribution than reconversion; it may enhance with intravenous gadolinium, can cause cortical destruction and may extend into the soft tissues.

83) By the middle of the third decade, the adult pattern of haematopoietic and fatty marrow distribution is established. Red marrow remains in all but which of the following locations?

- a. sternum
- b. clavicles
- c. ribs
- d. proximal humeri
- e. distal femora

83) e. \*\*\*

MRI is superior to other imaging modalities in evaluating red (haematopoietic) and yellow (fatty) bone marrow, as a result of its very high sensitivity for lipid, which is present in significantly higher concentrations in yellow marrow than in red. At birth, haematopoietic marrow is present throughout the entire skeleton. A predictable sequence of conversion of red to yellow marrow begins distally in the hands and feet, and migrates proximally (over a period of 20 years) until red marrow remains only in the axial skeleton and the proximal humeral and femoral metaphyses. Reversal of this process is called reconversion. Appreciation of the areas of remaining red marrow in an adult is important, because malignant marrow infiltration can have a similar appearance to haematopoietic marrow, with location being a major discriminator.

84) A 35-year-old woman of African origin is admitted to accident and emergency with acute abdominal and back pain with pyrexia. Radiographs of the chest, abdomen and lumbar spine show rib thinning with notching, sclerosis of the right humeral head and biconcave, 'fish-shaped', lumbar vertebral bodies. A subsequent radiograph of the skull reveals widening of the diploë with hair-on-end striations. What is the most likely underlying condition?

- a. neurofibromatosis
- b. thalassaemia major
- c. sickle cell disease
- d. syphilis
- e. Scheuermann's disease



84) c. \*\*

Sickle cell disease is a haemoglobinopathy that results from the presence of abnormal  $\beta$ -globin chains within haemoglobin, which may manifest as anaemia, infarction and superimposed infection. It is much more prevalent in those of African-Caribbean origin. Over time, the disease produces musculoskeletal abnormalities as a result of chronic anaemia, such as marrow proliferation (which produces the characteristic changes in the skull), marrow reconversion and extramedullary haematopoiesis. Other common skeletal complications include bone softening, infection or infarction.

87) On plain radiographs of the long bones or the spine, which of the following is not a recognized cause of a 'bone within a bone' appearance?

- a. infant physiology
- b. sickle cell anaemia
- c. nutritional disturbance
- d. renal osteodystrophy
- e. metastatic disease

87) d. \*\*\*

'Bone within a bone' is a term used to describe a radiographic appearance in which one bone appears to arise within another. It can be a physiological finding in a neonate or infant due to new bone formation. Pathological conditions that can cause the appearance include periosteal new bone formation, cortical splitting, subcortical osteopenia, altered bone growth, impairment of osteoclastic activity, altered bone metabolism, crystal deposition, and iatrogenic and technical radiological

factors. It is not a feature of renal osteodystrophy but is seen in hypervitaminosis D and in healing rickets.

90) A 30-year-old man visits his general practitioner complaining of recent onset of acne and discharging pustules on his palms. He has a history of several years of pain and swelling at the medial end of his right clavicle. Radiographs of the shoulder demonstrate hyperostosis and early ankylosis of the sternoclavicular joint. What is the most likely diagnosis?

- a. SAPHO syndrome
- b. suppurative osteomyelitis
- c. psoriatic arthritis
- d. Reiter's disease
- e. recurrent multifocal osteomyelitis

*Sternoclavicular joint is affected in 70-90%*

90) a. \*\*\*

Synovitis, acne, pustulosis, hyperostosis and osteitis (SAPHO) syndrome is a term encompassing several disease entities that demonstrate an association between rheumatological and cutaneous lesions. There may be a delay of several years between the onset of osseous symptoms and cutaneous manifestations. It is thought to be similar to chronic recurrent multifocal osteomyelitis in children.

The dominant radiographic abnormality is new and bizarre bone proliferation, with the sternoclavicular joint affected in 70–90% of cases.

97) Which of the following can cause a false-negative result in performing an ultrasound scan of the shoulder for suspected rotator cuff tear?

- a. rotator interval
- b. musculotendinous junction
- c. limited joint mobility
- d. anisotropy
- e. acoustic shadowing

97) c. \*\*

A false-negative result in this context is failure to identify pathology and to report incorrectly the ultrasound examination as normal. Limited shoulder mobility will not permit correct positioning of the shoulder for best interrogation of the whole of each tendon and may lead to non-visualization of a tear. Other causes of false negatives include technical

factors such as using an incorrect transducer (should be at least 7.5 MHz), poor focusing and poor transducer handling. There are also anatomical causes, including non-diastasis of the tendon fibres, scar tissue, bursitis, tendinosis and massive tear, with complete retraction of the tendon ends preventing their visualization. Anisotropy, poor transducer positioning or misinterpretation of the rotator interval, musculotendinous junction, supraspinatus–infraspinatus interface, acoustic shadowing and fibrocartilaginous insertion can all give rise to false-positive findings.

16. In a 26 year old woman with sickle cell disease, which one of the following would not be considered a typical musculoskeletal manifestation of the disease?
- a. Osteopaenia and trabecular thinning
  - b. 'Bone within bone' appearance
  - c. Avascular necrosis of the femoral head
  - d. Posterior vertebral scalloping
  - e. Fish deformity of the vertebrae

**16. d. Posterior vertebral scalloping**

Posterior vertebral scalloping is not a feature. The remainder are all classic features of sickle cell anaemia, along with 'hair-on-end' appearance of the skull due to coarse granular osteoporosis and widening of the diploe. Osteomyelitis is a feature and is due to salmonella in over 50% of cases.

20. Following a traumatic left elbow fracture, a young man complains of paraesthesia in his left ring and little fingers. He also starts to notice weakness of his left hand. A diagnosis of ulnar nerve entrapment is made. Which of the following muscles will not be affected?
- a. Abductor digiti minimi
  - b. Abductor pollicis brevis
  - c. Adductor pollicis
  - d. Flexor carpi ulnaris
  - e. Flexor digiti minimi

20. **b. Abductor pollicis brevis**

Abductor pollicis brevis is supplied by the median nerve and would therefore not be affected in an ulnar nerve injury. Due to the anatomic location of the ulnar nerve at the elbow, it can often be damaged leading to denervation and paralysis of the muscles supplied by the nerve. This includes the intrinsic muscles of the hand, which can be very debilitating. Injury to the ulnar nerve at the wrist would lead to severe muscle denervation sparing only the opponens pollicis, the superficial head of the flexor pollicis brevis and the lateral two lumbricals.

23. An elderly gentleman complaining of generalised aching in his lower limbs is shown to have bilateral distal tibial periostitis. There is no underlying bone lesion identified. Which of the following would be the most likely explanation?
- a. Arterial insufficiency
  - b. Thyroid acropachy
  - c. Trauma
  - d. Pachydermoperiostosis
  - e. Hypertrophic pulmonary osteoarthropathy

23. **e. Hypertrophic pulmonary osteoarthropathy**

The most likely explanation is hypertrophic osteoarthropathy. Thyroid acropachy changes usually occur in the upper limb. Venous stasis is a cause of periostitis rather than arterial insufficiency. Trauma would be unlikely to be bilateral unless there was a specific history. Pachydermoperiostitis is the idiopathic form of hypertrophic osteoarthropathy, it usually presents around adolescence and is usually associated with clubbing.

26. A young man with limited range of movement at the shoulder joint, a webbed neck and plain film findings of a hypoplastic scapula which is elevated and medially rotated with an associated omovertebral bone is likely to have which associated syndrome?
- a. Turner's syndrome
  - b. Down's syndrome
  - c. Klippel-Feil syndrome
  - d. Neurofibromatosis
  - e. Cleidocranial dysostosis

26. c. **Klippel-Feil syndrome**

The collective findings described are of a Sprengel deformity of the shoulder. This occurs as a result of failure of descent of the scapula secondary leading to both cosmetic and functional impairment. The male:female ratio is 3:1 and it is associated with Klippel-Feil syndrome, a condition in which there is fusion of vertebral bodies, and renal anomalies.

29. A 70 year old male presents with increasing pain in his right hip over the past month. There is no specific history of trauma. A plain radiograph demonstrates the presence of an incomplete fracture of the femoral neck arising from the lateral (convex) side. What is the most likely underlying abnormality of the femoral neck?
- a. Osteomalacia
  - b. Metastasis
  - c. Osteoid osteoma
  - d. Infection
  - e. Paget's disease

29. e. **Paget's disease**

Incremental fractures (banana fracture) along the convex side of the bone are classically associated with Paget's disease. These most commonly occur in the femur where they cause lateral bowing, and the tibia where they cause anterior bowing. Compression fractures of the vertebrae are also associated with Paget's.



30. A 75 year old woman presents with increasing pain in her left hip. She had a total hip replacement eight years ago on this side which has been asymptomatic ever since. Plain radiographs demonstrate a lucent line at the bone cement interface of the femoral component. The likely cause for this is:
- a. Infection
  - b. Metastasis
  - c. Loosening
  - d. Myeloma
  - e. Trauma

**30. c. Loosening**

Early changes (less than six months) are almost always due to infection. Up to four years, infection remains the most likely cause, but after this point loosening becomes more common. Every year, 38 000 hips are replaced in the UK. A routine postoperative film is usually performed; an excessively varus stem may lead to loosening.

37. A 24 year old man suffers a short oblique fracture of his distal tibia from a direct blow during a football game. He is treated with an intramedullary nail with a good reduction being achieved. Fourteen days later the foot becomes very tender, red and swollen but all haematological and biochemical parameters remain normal. Plain radiographs show spotty osteoporosis and subchondral erosions. Which of the following is the most likely diagnosis?
- a. Disuse osteoporosis
  - b. Charcot joints
  - c. Infection
  - d. Regional sympathetic dystrophy
  - e. Rheumatoid arthritis

**37. d. Regional sympathetic dystrophy**

This is the typical appearance, history and imaging findings for regional sympathetic dystrophy. This may occur following fractures or secondary to other pathologies such as primary or secondary bone tumours. There is overactivity of the sympathetic nervous system causing pain, swelling and hyperaemia with excessive bone resorption. This is usually in a periarticular distribution and may simulate other disease processes.

45. A dental radiograph of a 47 year old woman shows loss of the lamina dura of the majority of the teeth. Which of the following would be a possible cause?
- a. Osteopetrosis
  - b. Hypoparathyroidism
  - c. Scleroderma
  - d. Sickle cell anaemia
  - e. Myeloma

45. c. **Scleroderma**

The other causes of loss of the lamina dura include Cushing's disease, Paget's, hyperparathyroidism, osteoporosis, osteomalacia, leukaemia, metastases and Langerhans' cell histiocytosis. Both osteopetrosis and hypoparathyroidism cause thickening of the lamina dura of the teeth.

47. A 24 year old woman presents with worsening frontal headaches and a sixth nerve palsy. A non-enhanced CT shows a lesion situated within the clivus with associated bony destruction; there is soft-tissue extension into the nasopharynx. MRI shows a large inter-osseous mass which is isointense to brain T1-weighted imaging and hyperintense on T2. The most likely diagnosis is:
- a. Sphenoid sinus cyst
  - b. Meningioma
  - c. Nasopharyngeal carcinoma
  - d. Metastasis
  - e. Spheno-occipital chordoma

47. e. **Spheno-occipital chordoma**

The most likely cause is a spheno-occipital chordoma. This is associated with bony destruction in 90% of cases and is most usually within the clivus. Other sites include the sella, petrous temporal bone, floor of middle cranial fossa and jugular fossa. Sacrococcygeal chordoma is the most common subtype of chordoma and is usually located with the fourth or fifth sacral segments. Vertebral/spinal chordoma accounts for only 15–20% of all chordomas and is most often situated in the cervical spine.

54. A three month old boy presents with several small painful soft-tissue swellings which have developed over the mandibular region and the right clavicle. Plain films show marked periosteal new bone formation and localised soft-tissue swelling. There is also bone expansion with remodelling of old cortex. The most likely diagnosis is:
- ✓ a. Caffey disease
  - b. Hypervitaminosis A
  - c. Infantile myofibromatosis
  - d. Scurvy
  - e. Kinky hair syndrome

54. a. **Caffey disease**

The most likely diagnosis is Caffey disease. This is a relatively rare self-limiting condition which usually presents before six months of age. The mandible is the most common site and accounts for 80% of cases, followed by the clavicle and the upper limb bones.

59. A three-year-old boy attends A&E with a history of a seizure. He has known congenital cardiomyopathy. A chest radiograph shows sclerosis and expansion of several ribs. Previous plain films have shown bone islands within the vertebrae and long bones and bone cysts within the phalanges. Which of the following conditions would be likely to underly these findings?
- a. Down's syndrome
  - b. Tuberous sclerosis
  - c. Sturge-Weber syndrome
  - d. Neurofibromatosis
  - e. Sarcoidosis

59. b. **Tuberous sclerosis**

This is a multi-system autosomal dominant disorder affecting the central nervous system, kidneys, lung and heart. The classic triad of facial angiofibroma, epileptic seizures and mental retardation is only seen in approximately 30% of patients. Skeletal abnormalities include sclerotic calvarial patches or 'bone islands', thickening of diploe, expansion and sclerosis of ribs and periosteal thickening of long bones. Gracile ribs are often seen in association with Down's syndrome.

- 1 A young patient, of normal intelligence and with unaffected parents, presented with back pain. The patient was noted to have short limbs and characteristic facial features. Lumbar and thoracic spine plain radiographs showed a decreasing interpedicular distance caudally and posterior scalloping. Which chondroplasia is he most likely to have?
- a Achondrogenesis
  - b Roberts syndrome
  - c Kniest dysplasia
  - d Achondroplasia
  - e Pseudoachondroplasia

1 Answer D: Achondroplasia

This syndrome has features affecting most body parts: skull (flat nasal bridge, broad mandible, etc.), chest (decreased AP distance, short anteriorly flared concave ribs), spine (anterior beak in lumbar spine, decreased vertebral body height, scoliosis), pelvis ('tombstone' iliac bones from squaring, 'champagne glass' pelvic inlet) and extremities ('trident' hand, short femoral necks, etc.). Homozygous achondroplasia is lethal. Roberts syndrome is a rare disorder displaying a phocomelia (similar to infants affected by thalidomide during pregnancy), and usually facial defects such as cleft lip and palate and malformed ears. Kniest syndrome is a newly described chondrodystrophy, the main features of which are flat, elongated and irregular vertebral bodies, dumbbell-shaped long bones and flattened, squared-off epiphyses of the hand. Pseudoachondroplastic patients have a normal face and head but display limb shortening, irregular epiphyses, scoliosis, coxa vara and marked shortening of bones in hands and feet.

- 2 A 72-year-old patient on haemodialysis presented with joint pain and effusion of the right shoulder. An arthroscopic specimen stained positive with Congo red. Plain films showed preserved joint space. Which is the most likely diagnosis?
- a Rheumatoid arthritis
  - b Osteoarthritis
  - c Amyloid arthropathy
  - d Sarcoidosis
  - e Myeloma

2 Answer C: Amyloid arthropathy

Amyloid classically stains with Congo red and can be a primary or secondary process. Typical features include: bone pain, periarticular soft tissue swelling and carpal tunnel syndrome. Three patterns have been described: synovial articular pattern (amyloid arthropathy), diffuse marrow deposition and localised destructive lesion (amyloidoma, rarest form).

- 5 A neonate has copious bile-stained vomiting 12 hours after birth. The plain radiograph demonstrates a 'double-bubble' and the paediatrician on call is suspicious that the child has Down syndrome. What bony feature would support this diagnosis?
- a Hypotelorism
  - b A fracture of the odontoid peg
  - c Avascular necrosis of the femoral head(s)
  - d Epiphyseal flaring
  - e Posterior scalloping of the vertebral bodies

5 Answer A: Hypotelorism

Hypotelorism refers to an abnormally close distance between the eyes. Some of the features that occur with Trisomy 21 (Down syndrome) are: hypotelorism, atlantoaxial subluxation, flattening of the acetabular roof, metaphyseal flaring and anterior scalloping of the vertebral bodies. Consider abnormalities in the following categories: skull, axial skeleton, chest, pelvis, extremities and gastrointestinal.

- 6 Of one million people in a region, 100 have ankylosing spondylitis and on average four new cases are diagnosed each year. What is the incidence of ankylosing spondylitis in this population? (Options are cases per million or cases per million per year as appropriate.)
- a 4
  - b 25
  - c 100
  - d 104
  - e 400



6 Answer A: 4 (cases per million per year)

The incidence is a measure of the number of new cases in a period of time. The prevalence is the total number of cases present in the population.

- 7 A bone scan is performed for the investigation of shin splints in a young athlete who complains of lower limb pain on running. Which option best describes the most likely finding in this diagnosis?
- a Normal study
  - b Bilateral symmetrical uptake in the patellae (the 'hot patella sign')
  - c Linear symmetrical cortical uptake seen most avidly along the posterior aspects of the tibiae
  - d Linear asymmetrical uptake seen most avidly along the anterior aspects of the tibiae, the 'leading leg' being more avid
  - e Patchy uptake in the distal tibial shafts

- 7 Answer C: Linear symmetrical cortical uptake seen most avidly along the posterior aspects of the tibiae

Patchy uptake in shafts is more likely to indicate stress fracture, which may present in a similar fashion. The uptake in shin splints is usually diagnostic, but lateral views of the lower limbs are necessary to demonstrate the uptake along the posterior cortices. The hot patella sign is non-specific but not associated with the diagnosis of shin splints.

- 9 An 11-year-old girl presented with hip pain and an X-ray of her pelvis was taken. A lucent lesion with an area of periosteal reaction was visible. The periosteal reaction had a 'hair-on-end' configuration. What is the likely nature of any underlying lesion?
- a Normal finding at this age
  - b Likely benign tumour
  - c Likely aggressive processes
  - d Likely haemangioma
  - e Non-specific – may be benign or aggressive

**9 Answer C: Likely aggressive processes**

Periosteum is composed of two layers, outer fibrous and inner cellular, which has potential for osteoblastic potential. It is more active in childhood and therefore is visualised earlier in children. Periosteal reaction represents either new bone formation or periosteal elevation. The different types of periosteal reaction

are: lamellated, solid, speculated, sunburst or hair on end, Codman's triangle. Tumours presenting with speculated, sunburst, disorganised periosteal reaction or Codman's triangle are likely to represent aggressive processes.

Weniger A. Small Tumor of the Bone.

- 11** A 46-year-old man with haemophilia A has a history of a number of bleeds into the joints of his lower limbs. What feature would be expected on imaging?
- a Uniform sclerosis of all bones
  - b A 'squared' patella
  - c Expansion of the condylar surface
  - d Lateral slanting of tibiotalar joint
  - e High signal returned from synovium on T1- and T2-weighted images

**11 Answer A: A 'squared' patella**

Haemophilia is an X-linked condition, which affects males. Haemophilic arthropathy is caused by repeated bleeding into the joint, leading to pannus formation, which erodes cartilage and leads to loss of the subchondral bone plate and formation of subarticular cysts. Patients present in the first or second decade with a tense, red, warm joint and decreased range of movement. There is associated fever and elevated white count. On MR, low signal is returned from the hypertrophied synovium due to magnetic susceptibility of haemosiderin.

- 12 A seven-year-old child with Marfan syndrome is noted to have an abnormality on a skull X-ray. What is the most likely finding?
- a Osteopenia
  - b Dolichocephaly (scaphocephaly)
  - c Copper beaten skull
  - d Luckenschadel
  - e Brachycephaly

12 Answer B: Dolichocephaly (scaphocephaly)

Marfan syndrome is a connective tissue disorder of a mutation in the fibrillin-1 gene. It affects various systems: musculoskeletal, ocular, cardiovascular (in 60–98%), pulmonary and abdominal. The main musculoskeletal areas involved are: skull, hands, feet, spine and joints, with arachnodactyly, dolichocephaly, hallux valgus, scoliosis. Arachnodactyly is elongation of the phalanges and metacarpals. Dolichocephaly is where the head is disproportionately long and narrow. The fifth finger demonstrates a flexion deformity.

- 13 A 27-year-old patient with poorly developed finger and toe nails presented following a fall onto his knee. An X-ray demonstrated absence of the patella. What further feature would be likely?
- a Bilateral posterior iliac horns
  - b Avascular necrosis of the hip
  - c Liver dysfunction
  - d Early onset dementia
  - e Normal gait

**13** Answer A: Bilateral posterior iliac horns

Nail-patella syndrome is a rare autosomal dominant disorder with features of symmetrical meso- and ectodermal abnormalities. The aetiology is possibly a defect in collagen metabolism. It generally becomes apparent in second and third decades with hypoplasia or absence of thumb and index fingernails, an abnormal

gait and renal dysfunction. The diagnostic feature radiographically is bilateral posterior iliac horns, which are present in 80%.

**15** An 80-year-old man presented with right hip pain following a fall was assessed initially with plain radiographs of his hip and pelvis and then a bone scan. What feature would be suggestive of Paget's disease?

- a Osseous expansion
- b Cortical thinning
- c Trabecular thinning
- d Thinning of iliopubic and ilioischial lines
- e Photopenic lesions on bone scan

**15** Answer A: Osseous expansion

Paget's is a multifocal skeletal process, which results from disordered and excessive bone remodelling. It has several stages: active, osteolytic phase, middle, mixed phase and an inactive, quiescent late phase. Radiography alone is only 13–74% sensitive. Scintigraphy and radiography are 60% sensitive. Bone scan alone is over 90% sensitive. Commonly affected areas are: skull, long bones, ribs, pelvis and spine. The key features are osseous expansion with thickening of the cortex and coarsening of the trabecular pattern.

- 16 A 37-year-old man presented as an emergency after falling off his motorbike. He was previously asymptomatic but investigations revealed multiple fractures including bilateral femoral fractures and a skull fracture. His bones were noted to be globally abnormal with sclerosis and there was a 'bone within a bone' appearance of several of the vertebrae. Alternating sclerotic and lucent bands were visible in his iliac wings and the base of his skull was noted to be particularly dense. What is the most likely diagnosis?
- a Osteomalacia
  - b Osteopetrosis
  - c Osteopoikilosis
  - d Osteoporosis
  - e Osteosclerosis

16 Answer B: Osteopetrosis

Osteopetrosis is also known as marble bone disease and is a rare disease of abnormal osteoclast activity where there is failure of resorption and remodelling, which leads to sclerotic, thick bone, which is weak and brittle. The types include: infantile autosomal recessive (is either fatal in utero or life expectancy is up to middle age), benign adult autosomal dominant, phenotypes 1 and 2 (normal life expectancy). The metaphyseal striations are longitudinal.

- 19 A 45-year-old woman with a history of a systemic disease presented with hand pain. What feature would favour a diagnosis of sarcoidosis over scleroderma?
- a Reticulated trabecular pattern
  - b Calcinosis of soft tissues
  - c Sclerosis of terminal phalanges
  - d Soft-tissue swelling
  - e Bony erosions of carpal bones

19 Answer A: Reticulated trabecular pattern

Osseous involvement in sarcoid is uncommon, being reported in 6–20% of cases, and tends to affect the small bones of the hands and feet. The key features are a reticulated trabecular pattern, cyst-like lesions and destruction of the terminal phalanges. Other bony lesions are diffuse sclerosis of vertebral bodies and osteolytic changes in the skull.



- 21 A 36-year-old man presented with leg pain and an abnormality was noted on the initial radiograph. He then had a bone scan, which appeared normal with no evidence of the abnormality. What would be a possible explanation for this?
- a Acute fracture
  - b Osteomyelitis
  - c Lymphoma
  - d Primary hyperparathyroidism
  - e Paget's disease

21 Answer A: Acute fracture

All the other answers are for causes of an abnormal bone scan with no findings (or minimal changes) on plain radiography. Causes of a positive radiograph with a normal bone scan are: metabolically inactive benign conditions (bone cysts/bone island/exostoses), recent fractures (less than 48 hours), multiple myeloma, osteoporosis, and rarely metastases if there is no osteoblastic activity.

- 24 A series of radiographs of a patient's spine shows hypoplasia of the pedicles, transverse processes and spinous processes. There is also a sharply angled kyphosis in the lower thoracic spine and dural ectasia in the lower lumbar spine with dumbbell-shaped enlargement of a number of the neural foramina. What is the most likely diagnosis?
- a Klinefelter's syndrome
  - b Neurofibromatosis type 1
  - c Down syndrome
  - d Tuberous sclerosis
  - e Von Hippel-Lindau syndrome

24 Answer B: Neurofibromatosis type 1

These features are typical of the appearance of the spine. In NF1 the musculoskeletal manifestations tend to predominate.

- 39 You are preparing the equipment required to perform a bone biopsy. When would a coaxial (introducer-sheathed) needle offer an advantage?
- a To biopsy a deep lesion
  - b To biopsy a superficial lesion
  - c To biopsy a large, easy to target lesion
  - d To obtain a larger specimen
  - e To reduce cost

39 Answer A: To biopsy a deep lesion

Although more expensive, introducer-sheathed biopsy needles have the advantage of allowing deeper biopsies to be taken. They are often used for smaller, more difficult to target biopsies. Smaller specimens are taken with introducer-sheathed needles.

- 41 A 67-year-old man was noticed to have a mixed sclerotic and lucent region in his proximal tibia with bowing of the bone and marked thickening of the cortex. There was no periosteal reaction. What is the most likely diagnosis?
- a Paget's disease
  - b Aneurysmal bone cyst
  - c Rickets
  - d Non-ossifying fibroma
  - e Chondromyxoid fibroma

41 Answer A: Paget's disease

A flame-shaped lucency and bone expansion with cortical thickening are typical features of Paget's disease. An aneurysmal bone cyst would have thin, intact cortex and tends to affect the metaphysis. Non-ossifying fibromas usually present in children.

- 50 A 27-year-old Afro-Caribbean patient with known sickle cell disease presented with ongoing pain left arm pain following a crisis and was found to have osteomyelitis of his humerus. What is the most likely causative organism?
- a *Proteus mirabilis*
  - b *Escherichia coli*
  - c *Staphylococcus aureus*
  - d *Mycoplasma pneumoniae*
  - e *Corynebacterium diphtheriae*

50 Answer C: *Staphylococcus aureus*

Some series suggest that *Salmonella* is the most likely cause but others have found that *Staphylococcus* is the commonest cause in this population.

- 67 A young adult female with severe acne had several episodes of inflammatory joint symptoms and a radiograph of her knee showed juxtaarticular osteoporosis. She also had evidence of osteosclerosis of several vertebrae with paravertebral ossification. What other skin rash is she at high risk of?
- a Erythema nodosum
  - b Heliotrope rash
  - c Palmoplantar pustulosis
  - d Pemphigus
  - e Psoriasis

67 Answer C: Palmoplantar pustulosis

The patient has SAPHO syndrome (synovitis, acne, palmoplantar pustulosis, hyperostosis and osteitis).

- 68 A five-year-old boy injured his leg in the playground and a radiograph was obtained the same day. This demonstrated a pseudoarthrosis of the fibula. What is the most likely underlying diagnosis?
- a Non-union of fracture
  - b Osteomyelitis
  - c Neurofibromatosis
  - d Chondroectodermal dysplasia (Ellis-van Creveld syndrome)
  - e Holt-Oram syndrome

68 Answer C: Neurofibromatosis

Other possibilities are fibrous dysplasia or osteogenesis imperfecta. Non-union could give this appearance but it is unlikely given the history.

- 69 A patient presented with pneumonia and had a chest radiograph. This showed absence of the clavicles, 13 pairs of ribs and a narrowed thorax. What is the likely inheritance of the underlying condition?
- a X-linked
  - b Spontaneous mutation
  - c Mitochondrial
  - d Autosomal recessive
  - e Autosomal dominant

69 Answer E: Autosomal dominant

The patient has cleidocranial dysostosis.

- 70 A 30-year-old man had a shoulder radiograph following an injury that showed no fracture, but there were multiple small (up to 6mm) ovoid bone islands throughout the bones with the long axis running parallel to the bone. He remembered that his father had a similar condition and asks whether it puts him at an increased risk of malignancy. What is the increased risk?
- a No increased risk
  - b High risk of colorectal carcinoma
  - c High risk of osteosarcoma
  - d Moderate increased risk of colorectal carcinoma
  - e Moderate increased risk of osteosarcoma

70 Answer A: No increased risk

The patient has osteopoikilosis, which is not premalignant or associated with other malignancies. Gardner's syndrome is a familial polyposis syndrome associated with bone islands, but the usual finding is of fewer larger bone islands.

- 5 A 17-year-old patient with Ehlers-Danlos syndrome is due for further investigations. What investigation would be contraindicated?
- a Aortography
  - b Barium enema
  - c Intravenous urogram
  - d CT brain
  - e Tc-99m bone scan

5 Answer A: Aortography

Aortography is contraindicated because of the complications of aortic rupture and haematoma. Ehlers-Danlos is an autosomal disease of connective tissue due to altered collagen synthesis. There are 10 types, mostly in males. Features affect the following systems: soft tissues, skeleton, chest, arteries and GI tract.

- 7 A 62-year-old patient with non-specific bone pain is referred for a bone scan, which shows avid diffuse uptake in the right femur corresponding to a thickened cortical outline. The bone scan is otherwise normal for age. What is the most likely diagnosis?
- a Monostotic fibrous dysplasia
  - b Monostotic Paget's disease
  - c Osteomalacia and insufficiency fracture
  - d Myelofibrosis
  - e Osteosarcoma

7 Answer B: Monostotic Paget's disease

These are typical appearances but radiological correlation should be performed.

- 9 A 10-year-old schoolboy had a fall and bruised his right knee badly. There was an open wound that was not treated until the following day. After a further two days he became systemically unwell with a fever. His knee was extremely tender, swollen, and the movement was restricted. Which of the following is a feature of septic arthritis?
- a Usually due to *Haemophilus*
  - b Periarticular soft tissue swelling is rare
  - c Blurring of the periarticular fat planes is common
  - d The joint space widens after a few weeks
  - e A joint effusion is not usually present



9 Answer C: Blurring of the periarticular fat planes is common

Septic arthritis usually occurs in hip, knee, shoulder, elbow and ankle. *Staphylococcus aureus*, followed by group A *Streptococcus*, are the most common causes. Other radiographic features include periarticular soft-tissue swelling, an effusion, periarticular osteopenia and, later, joint space narrowing. Ultrasound may help identify septic arthritis before cartilage lysis occurs. The hallmark is joint effusion in a patient with signs of a joint infection.

11 A 55 year old with a history of several severe attacks of rheumatic fever presented with a polyarthropathy affecting the metacarpophalangeal joints of both hands with ulnar deviation and subluxation. The joint spaces were preserved and they were able to voluntarily correct the subluxation. What is the most likely diagnosis?

- a Jaccoud's arthropathy
- b Rheumatoid arthropathy
- c Amyloid arthropathy
- d Psoriatic arthritis
- e Haemophilic arthropathy

11 Answer A: Jaccoud's arthropathy

This primarily affects the hands and occasionally the hallux. Radiographic features include muscular atrophy, periarticular swelling of the small joints of hands and feet, ulnar deviation and flexion of the MCP joints most marked in fourth and fifth finger without joint narrowing or erosion.

13 A 56-year-old woman presented with an ankle deformity and was found to have reduced proprioception of this leg such that it was only minimally tender despite dislocation and marked bone destruction being visible on radiographs. What is a possible underlying cause?

- a Charcot-Marie-Tooth
- b Hyperthyroidism
- c Prolonged use of antibiotics
- d Acromegaly
- e Use of hyoscine butylbromide (Buscopan®)

**13 Answer A: Charcot-Marie-Tooth**

Neuropathic osteoarthropathy is a traumatic arthritis associated with loss of sensation and proprioception of the affected limb. The causes can be congenital (Charcot-Marie-Tooth, Ehlers-Danlos), acquired (central/peripheral neuropathy, neurosyphilis, diabetes mellitus) or iatrogenic. Iatrogenic causes include: prolonged use of systemic or intra-articular steroids, and prolonged use of pain relieving drugs.

- 15** An elderly woman with known Paget's disease of her skull presented following a fall. According to her husband she had also been becoming more confused recently. What feature secondary to Paget's disease is most likely?
- a Osteoblastoma
  - b Cerebral hemisphere compression
  - c Hydrocephalus
  - d Hypocalcaemia
  - e Leukaemia

**15 Answer C: Hydrocephalus**

(Secondary to basilar impression) The four main categories for complications of Paget's disease are: associated neoplasia, insufficiency fractures, neurologic entrapment, and early onset osteoarthritis.

Neoplasia includes sarcomatous transformation, multicentric giant cell tumour or lymphoma. Banana fractures are tiny horizontal 'Looser lines' on convex surfaces of lower extremity long bones. Other insufficiency fractures include

vertebral compression fractures. Neurologic complications involve either basilar impression leading to hydrocephalus and brainstem compression, or spinal stenosis.

- 20 A patient with a chromosomal disorder was noted to have a number of musculoskeletal abnormalities. What feature would favour the diagnosis of Turner's syndrome over Down syndrome?
- a Atlantoaxial subluxation
  - b Tall stature
  - c Madelung's deformity
  - d Gracile ribs
  - e Anterior scalloping of vertebral bodies

20 Answer C: Madelung's deformity

Turner's syndrome is due to an XO genotype and patients are usually of short stature. Associated abnormalities include: coarctation, aortic stenosis, horseshoe kidneys, a shield-shaped chest, squared lumbar vertebrae and thinned ribs.

Madelung's deformity is due to abnormal growth at the distal radial physis leading to a volar and ulnar tilt to the distal radius with overgrowth of the ulna. It is associated with Turner's syndrome, dyschondrosteosis and diaphyseal aclasis but may also be post-traumatic or post-infective.

- 21 A 60-year-old woman with a history of breast cancer 10 years previously presented with back pain and a bone scan was arranged. Other than metastatic disease, what would be a cause of increased uptake?
- a Multiple myeloma
  - b Dental disease
  - c Haemangioma
  - d Acute fracture
  - e Radiotherapy field

21 Answer B: Dental disease

A radiotherapy field is a photopenic area (along with internal or external artefacts, avascular lesions, multiple myeloma, haemangioma and advance carcinoma). Increased uptake can be pathological or physiological. Pathological factors include: metastatic disease, joint disease, traumatic or stress fracture, post-operatively, Paget's, disseminated secondary disease, metabolic bone disease and dental infection. Physiological factors include: artefacts, age factors, soft-tissue uptake.

- 23 A 25-year-old motorcyclist who was in collision with a bus is being treated for a pelvic fracture and haematuria. On examination he has perineal ecchymoses. He is due to have a CT for further assessment of his urinary tract. How long after injection of 100 mL of low osmolar iodinated contrast at 3.5 mL/second into the antecubital fossa should images be acquired?
- a Immediately
  - b 25 seconds
  - c 60 seconds
  - d 4 minutes
  - e 30 minutes

23 Answer D: 4 minutes

The aim is to acquire the images once contrast has reached the bladder and of the options available 4 minutes is the best choice.

- 27 A 55-year-old lady with rheumatoid arthritis presented to the Emergency Department with sudden onset pain and swelling on the medial side of her left foot. Clinical examination revealed marked weakness of plantar flexion and inversion on the left, but normal power on the right. What tendon is most likely to have been injured?
- a Extensor digitorum
  - b Peroneus tertius
  - c Tibialis anterior
  - d Flexor hallucis longus
  - e Tibialis posterior

27 Answer E: Tibialis posterior

Spontaneous tibialis posterior rupture tends to occur in those with underlying pathology, especially rheumatoid arthritis. The typical presentation is in a woman of 40–60 years and the presenting signs and symptoms are pain, difficulty walking, and swelling along the medial malleolus and the arch of the foot. Traumatic rupture is more common in a younger age group and is not normally secondary to another pathology.

- 38 A 12 year old presented with a large lesion in their distal femur. What approach would be most appropriate for bone biopsy?
- a Medial approach
  - b Lateral approach
  - c Posterior approach
  - d Anterior approach
  - e Trans-venous percutaneous approach

38 Answer A: Medial approach

A medial approach is advocated to avoid the suprapatellar pouch and avoid an intra-articular track. A lateral approach is used for laterally placed masses in lower and upper femur, a posterior approach has greater risk of neurovascular damage and an anterior approach may compromise knee extension. There is no internal approach.

- 53 A 66-year-old man presented with a five-month history of back pain. There were no positive findings on examination and a series of blood tests were arranged. These showed: WCC  $3.7 \times 10^6/\text{mL}$ , haemoglobin 10.3 g/dL, haematocrit 31%, MCV 85 fl, platelets  $110 \times 10^6/\text{mL}$ , total protein 85 g/L, albumin 40 g/L. A chest radiograph showed clear lungs but a number of lucencies in the vertebral bodies. A bone marrow biopsy yielded a red jelly-like material. What cell type is it most likely to contain?
- a Giant cells
  - b Fibroblasts
  - c Plasma cells
  - d Metastatic renal carcinoma cells
  - e Osteoblasts

53 Answer C: Plasma cells

The patient has multiple myeloma with a high serum globulin.



- 60 A 38-year-old woman presented with neck pain and motor weakness and was found to have a mass at C6-T2, which was ultimately proven to be an ependymoma. In which part of the spinal canal is this lesion most likely to have originated?
- a Vertebral body
  - b Extra dural
  - c Dural
  - d Subdural
  - e Intramedullary

60 Answer E: Intramedullary

Ependymomas are intramedullary tumours.

- 66 A 12-year-old boy presented with ankle pain and a radiograph showed a metaphyseal lucency with dense surrounding sclerosis with a thin lucent channel extending towards the growth plate. The lesion was thought to be a Brodie's abscess. What is the most likely causative organism?
- a *Proteus mirabilis*
  - b *Escherichia coli*
  - c *Staphylococcus aureus*
  - d *Salmonella* species
  - e *Streptococcus milleri*

66 Answer C: *Staphylococcus aureus*

Brodie's abscesses are more common in children and tend to affect the end of tubular bones, most commonly the distal tibia or femur.

- 67 A child with an absent thumb and hypoplastic radius has also required treatment for a symptomatic arrhythmia and VSD. What is the most likely underlying unifying diagnosis?
- a Down syndrome
  - b Chondroectodermal dysplasia (Ellis-van Creveld syndrome)
  - c Holt-Oram syndrome
  - d Hailey-Hailey syndrome
  - e Marfan syndrome

67 Answer C: Holt-Oram syndrome

This is a rare syndrome with autosomal dominant inheritance characterised by radial ray limb anomalies and congenital cardiac disease.

- 3 An 18-year-old male of African origin with known sickle cell disease presents to the Emergency Department with severe pain in his right thigh. The pain started suddenly two days ago and has not settled with simple analgesics. Plain radiographs are performed which reveal a bone infarct. What appearance would be expected at this time?
- a Increased uptake on the bone scan
  - b Sclerosis
  - c Calcification
  - d Diminished uptake in medullary RES
  - e Radiographic changes without cortical involvement

3 Answer D: Diminished uptake in medullary RES

Features differ between the acute and healing phase. In medullary infarction, the nutrient artery is involved. In cortical infarction, the nutrient artery and periosteal vessels are affected. In the acute phase of medullary infarction, there are no radiographic changes without cortical involvement and decreased uptake on the bone marrow scan with increased uptake after a collateral circulation is established. In the healing phase (complete healing, fibrosis or calcification) the appearances are of serpiginous or linear calcification peripherally, with dense bone from revascularisation.

- 9 A 67-year-old man complains of pain in both wrists and ankles. The general practitioner discovers clubbing on digital examination. Plain radiographs are requested, which show changes consistent with hypertrophic osteoarthropathy (HOA). What is the most likely underlying finding in this patient?
- a Adrenal adenoma
  - b Glioblastoma
  - c Thyroid carcinoma
  - d Nephroblastoma
  - e Bronchiectasis

9 Answer E: Bronchiectasis

Hypertrophic osteoarthropathy is a syndrome of proliferative periostitis of the long bones, digital clubbing and arthralgia. Symptoms include pain and swelling of the wrist and ankles. Non-small-cell lung cancer is the most common malignant association. HOA is cited to be present in 31% of lung cancer patients and often precedes chest symptoms. Ectopic production of growth factors is thought to be the underlying causative factor. Other neoplasia in which HOA is seen include: pulmonary metastases (secondary to breast, nasopharyngeal tumours, renal cell carcinoma, melanoma, osteosarcoma) as well as benign conditions (benign pleural fibroma and bronchiectasis).

- 11 A 13-year-old boy presented to his GP with loss of appetite, vomiting, constipation and abdominal pain. His conjunctival membranes were pale. Plain radiographs showed bands of increased density at metaphyses of tubular bones and a 'bone in bone' appearance. Which of the following is most likely to be the cause of these symptoms and findings?
- a Active rickets
  - b Lead poisoning
  - c Zinc poisoning
  - d Kennedy disease
  - e Organic solvent poisoning

**11 Answer B: Lead poisoning**

The pathology of this involves lead concentrating in the metaphyses of growing bones (distal femur most often, then ends of tibia and then distal radius). These are known as lead lines, occur in a chronic state of poisoning and are growth arrests. The differential diagnosis is healed rickets, leukaemia, scurvy and normal increased density in infants less than three years of age. As lead and calcium are used interchangeably by bone, lead deposition occurs in high concentrations in growing bones, with the greatest concentration in the metaphyses, particularly those in the distal femora, ends of the tibiae and distal radii, as these are the parts of the skeleton that grow most rapidly. Risk factors include: exposure to lead paint, especially in old houses, eye makeup, occupational exposure.

- 12** A 30-year-old patient with no family history of joint or connective tissue disease presented with a stiff leg. X-rays revealed flowing ossification within a dermatomal distribution. What is a further feature of this condition?
- a It is caused by Epstein-Barr virus
  - b It generally does not cross joints
  - c Extension contractures of the knee
  - d Rapid course in adults
  - e Fibrosis of overlying skin is typical

**12 Answer E: Fibrosis of overlying skin is typical**

Melorheostosis is a nonhereditary disease of unknown aetiology, which has a slow course in adults and a rapid course in children. It has multiple associations: osteopoikilosis, osteopathia striata, blood vessel malformations. It is generally present in one limb or in a dermatomal distribution. Physical signs include thickening and fibrosis of the overlying skin and typical features include the 'dripping candle wax' sign – blotches of sclerosis along a tubular bone, from proximal to distal. It can cross joints leading to flexion contractures or fusion. In addition, genu varus, genu valgus and limb length discrepancy can occur.

- 18 An 18-year-old male with a skin rash on his face had a history of a left knee injury. He had a plain film of his skull to exclude a metal foreign body prior to an MRI scan of his leg, which showed multiple sclerotic lesions in the skull. Films of his initial presentation with his knee injury a year previously showed similar sclerotic lesions with a periosteal reaction in the long bones of his leg and cystic lesions in the distal phalanges of his foot. What is the most likely diagnosis?
- a Achondroplasia
  - b Tuberous sclerosis
  - c Von Hippel-Lindau syndrome
  - d Psoriatic arthritis
  - e Marfan syndrome

18 Answer B: Tuberous sclerosis

Tuberous sclerosis is an autosomal-dominant condition that presents with seizures, mental retardation and skin lesions. There are multisystem features: CNS, renal, skeletal, pulmonary and cardiac. Skeletal lesions are present in up to half of patients.

- 21 A 67-year-old woman with back pain is investigated with an MRI scan and areas of increased bone marrow signal on T2-weighted images are noted. What is a possible cause?
- a Multiple myeloma after treatment
  - b Lymphoma
  - c Gaucher's disease
  - d Radiotherapy
  - e Sclerotic metastases

**21 Answer D: Radiotherapy**

Processes that appear high signal on T2 include: osteoporotic vertebral collapse, radiotherapy, haemangiomas, type 1 and 2 vertebral end plate changes. Both lytic and sclerotic metastases return low signal on T1, with lytic metastases returning high signal on T2 and sclerotic low signal on T2. Myeloma can appear low signal after treatment. Lymphoma and Gaucher's disease tend to be isointense on T2-weighted imaging.

- 28** An 18-month-old child presents to the Emergency Department with abdominal pain and her father gives the history that she fell while running. Examination reveals a distressed child with widespread bruises of different ages. Non-accidental injury (NAI) is suspected and a skeletal survey is performed. What injury is most suspicious for NAI?

- a Spiral fracture of the tibia
- b Fracture of left seventh rib posteriorly
- c Greenstick fracture of ulna
- d Supracondylar fracture of the humerus
- e Torus fracture of the radius

**28 Answer B: Fracture of left seventh rib posteriorly**

Injuries suggestive of NAI include: metaphyseal corner, posterior rib, scapula and spinous process fractures, subependymal haemorrhages, bruises of different ages, and fractures not consistent with the expected stage of development of the child. For this reason, spiral fractures of the long bones would be consistent with an injury sustained by a walking toddler, but would be unusual below 18 months of age. Greenstick fractures are common in all children and are not in themselves suspicious for NAI. A supracondylar fracture is plausible if the history is suggestive; for example, falling from a climbing frame. Posterior rib fractures and metaphyseal corner fractures are particular common fractures in the setting of NAI.



- 58 A female neonate was born prematurely after a pregnancy complicated by polyhydramnios. A USS of the sacral region demonstrated an 18-cm solid cystic mass and pelvic X-ray demonstrated a mass with amorphous calcification. What blood test would be most helpful in making the diagnosis?
- a Beta HCG
  - b Full blood count
  - c Alpha feta protein
  - d Liver function tests
  - e Urea and electrolytes

58 Answer C: Alpha feta protein

Sacroccocygeal teratoma is the most common solid tumour occurring in the newborn and alpha feta protein is raised in malignant teratomas. It is more common in girls and is associated with other congenital anomalies such as spinal dysraphism, sacral agenesis, hydronephrosis, imperforate anus and gastroschisis. Sacroccocygeal teratomas are typically mixed cystic/solid and on MRI they are heterogeneous with high signal on T1-weighted images. The older the child is at presentation the more likely the tumour is to be malignant.

- 65 A patient, a keen cross-country runner, was investigated for shin pain and plain radiographs appeared normal. The attending doctor was concerned they may have an occult stress fracture. Which investigation would be most sensitive?
- a Repeat plain films after one week
  - b CT scan
  - c MRI scan
  - d Triple phase Tc99m methylene-diphosphonate (MDP) bone scan
  - e Gallium-67 white cell scan

- 65 Answer D: Triple phase Tc-99m methylene-diphosphonate (MDP) bone scan

Plain radiography is often used initially but generally only shows changes late on in the process, including endosteal and periosteal reaction. Triple-phase bone scintigraphy detects osteoblastic activity, which occurs during remodelling and is very sensitive. False positive results can occur in infection, osteonecrosis and neoplasia. CT is less sensitive than bone scintigraphy and MRI but it is useful in areas where plain film is limited and is more sensitive than plain film or MRI for detecting cortical fractures.

- 68 A child with obvious leg length discrepancy was found to have proximal focal femoral deficiency. What other structure(s) is often absent?
- a Corpus callosum
  - b Ossicles
  - c Cochlea
  - d Patella
  - e Clavicles

- 68 Answer D: Patella

This rare syndrome is due to in utero exposure to a toxin such as thalidomide. It is often associated with fibular hemimelia and absence of the patella.

- 69 A 15-year-old boy presented with premature ageing and was of short stature. His skin and muscles began to atrophy and he developed diabetes. A chest radiograph showed resorption of the lateral portions of the clavicles and the chest was narrow with thin ribs. He eventually died of a myocardial infarction at 29 years of age. What is the likely inheritance of his condition?
- a X-linked recessive
  - b X-linked dominant
  - c Mitochondrial
  - d Autosomal recessive
  - e Autosomal dominant

- 69 Answer D: Autosomal recessive

He had progeria, which often presents with absence of the adolescent growth spurt and beginning of premature ageing.

**1. A 50-year-old man who has been previously well presents with low back pain. Plain film reveals an osteolytic midline lesion in the lower sacrum containing secondary bone sclerosis in the periphery, as well as amorphous peripheral calcifications. A lateral film shows anterior displacement of the bladder and rectum. He subsequently develops faecal incontinence. No additional lesions were discovered after imaging of the whole spine. What is the most likely diagnosis?**

- A. Osteomyelitis.
- B. Ewing's sarcoma.
- C. Chordoma.
- D. Myeloma.
- E. Sacrococcygeal teratoma.

**1. C. Chordoma.**

Plain film is very insensitive for detecting sacral lesions. Metastatic disease is much more common in the sacrum than primary malignancy. Chordoma is the most common primary sacral lesion. It is derived from the embryonic remnants of the notochord and is thus almost always found in the midline or a paramedian location with respect to the spine. It is most commonly found in the sacrum (50%), clivus (35%), and vertebrae (15%). A chordoma manifests as a destructive, lytic lesion, commonly with internal calcifications, at both plain radiography and CT. A large presacral soft-tissue component is usually present, as are soft-tissue components within the sacrum and sacral canal. Symptoms can include pain, sciatica, and rectal bleeding as well as other bowel and bladder symptoms, reflecting compromise of sacral nerves. The tumours can extend across the adjacent disc space and sacroiliac joint.

On MRI, chordomas demonstrate low to intermediate signal intensity on T1WI and prominent increased signal intensity on T2WI. Enhancement of the soft-tissue components is variable, yet often moderate, on both CT and MR images. Chordomas demonstrate a prominent vascular stain at angiography. They are locally aggressive and develop in locations that do not permit easy surgical cure. There is an almost 100% recurrence rate; tumour seeding along biopsy tracts and surgical incisions can lead to multicentric local recurrences. Metastasis occurs in 5–43% to liver, lung, regional lymph nodes, peritoneum, skin, and heart. The 5-year survival rate is 66% for adults.

Osteomyelitis in the sacrum is most often due to contiguous spread from a suppurative focus and we are told this patient was previously well. Ewing sarcoma would occur at a younger age (peaking at 15 years, 90% manifest between the ages of 5 and 30). In the case of myeloma it would be atypical for the rest of the spine to be uninvolved. The sacrococcygeal region is the most common location of teratomas discovered in infancy. It is only rarely discovered in adulthood. Teratomas are composed of a mixture of cystic and solid components.

The other lesions to be included in the differential diagnosis of such a sacral mass are metastasis, sarcomas, GCT, chondrosarcoma, and ependymoma.

**11. A 75-year-old male with a history of backache undergoes plain radiographs of the lumbar spine, which demonstrate diffuse bone sclerosis. An MRI demonstrates diffuse low signal intensity of bone marrow on all sequences with no architectural distortion. The MRI planning sequence demonstrates splenomegaly. What is the diagnosis?**

- A. Sickle-cell anemia.
- B. Lymphoma.
- C. Osteoblastic metastasis.
- D. Myelofibrosis.
- E. Myeloma.

**11. D. Myelofibrosis.**

This is associated with collagen proliferation in the marrow, which may be primary or secondary/ reactive following other myeloproliferative disorders. The highly structured collagen matrix has tightly bound protons that do not resonate or produce significant signal. As a result the marrow is of diffuse low signal intensity on all sequences. There is also no architectural distortion.

In contrast, myeloma, metastases, and lymphoma are generally associated with focal or multifocal signal abnormalities. Sickle-cell anaemia causes bone sclerosis secondary to bone infarcts, which have an irregular appearance.

In myelofibrosis, splenomegaly is secondary to extramedullary hematopoiesis. The presence of splenomegaly is helpful in limiting the differential diagnoses. Sickle-cell anaemia is associated with a small, sometimes calcified, spleen due to autoinfarction.

**13. A 56-year-old man has a 6-week history of dull discomfort just above his right ankle. A plain ankle radiograph is performed and this demonstrates a relatively ill-defined area of lucency in the distal tibial metaphysis. An underlying aggressive lesion is suspected and the patient is referred for an MRI of the distal right leg. This shows a rather serpiginous-shaped lesion in the distal right tibia. A parallel rim of hypo- and hyperintensity is seen on one of the imaging sequences, which is very helpful in confirming that the lesion is secondary to metadiaphyseal osteonecrosis rather than a neoplasm. On which imaging sequence is this parallel rim most likely to be seen?**

- A. GET2\*WI.
- B. Fast spin echo (SE) T1WI.
- C. Fast SE T2WI.
- D. Fast SE STIR.
- E. Fast SE T1WI post gadolinium.



**13.C. Fast SE T2WI.**

The parallel rim of hypo- and hyperintensity seen on T2WI refers to the 'double line' sign, which is almost pathognomonic of osteonecrosis. It is most commonly associated with avascular necrosis of the femoral head, but can be seen in osteonecrosis at other sites on MRI. The 'double line' sign constitutes a hyperintense inner border (inflammatory response of bone with granulation tissue), with a hypointense periphery (reactive bone interface).

The characteristic plain radiographic pattern of metadiaphyseal osteonecrosis is that of a serpentine ring-like band of sclerosis that separates a central necrotic zone of variable lucency from surrounding normal marrow, although this pattern is a relatively late manifestation of osteonecrosis. Earlier in the course of the disease, osteonecrosis may result in a poorly defined region of lucency within the medullary space, a feature that may be indistinguishable from a lytic neoplastic process on x-ray. MRI is then very useful in these cases by showing the serpentine low signal rim of the lesion on T1WI. On T2WI, the rim of the lesion may have low signal, high signal or both (the 'double line' sign), the latter being the most specific sign for osteonecrosis.

**16. A 35-year-old female with a history of flushing, pruritis, and diarrhoea is referred for a small bowel series. A barium study demonstrates irregular diffuse thickening of small bowel folds. There is also diffuse osteosclerosis. Laboratory tests reveal elevated serum tryptase level. What is the diagnosis?**

- A. Mastocytosis.
- B. Intestinal lymphangectasia.
- C. Amyloidosis.
- D. Waldenstrom's macroglobulinaemia.
- E. Whipple's disease.

**16.A. Mastocytosis.**

This is a rare disorder characterized by proliferation of mast cells in the skin, bone marrow, liver, spleen, lymph nodes, and small bowel. Histamine released from mast cells is responsible for the associated symptoms of episodic flushing, pruritis, hypotension, and diarrhoea. The serum tryptase level is also elevated in mastocytosis.

Whilst the other conditions mentioned could also cause diffuse thickening of small bowel folds, the associated clinical laboratory findings and osteosclerosis are diagnostic of mastocytosis.

**17. You are looking at an MRI of the knees of a 16-year-old male. There is widening of the distal femoral metaphyses, with a widened intercondylar notch bilaterally. There is mild loss of joint space height in the medial tibio-femoral compartment, with subchondral cyst formation on the left, with preserved joint space but subchondral erosions on the right. The ligaments are intact. GE sequences reveal blooming artefact. Synovial enhancement causing joint erosion is noted on the enhanced T1WI sequence. What is the likely diagnosis?**

- A. Juvenile arthritis.
- B. Pigmented villonodular synovitis (PVNS).
- C. Amyloid.
- D. Haemophilia.
- E. Tuberculous arthritis.

**17. D. Haemophilia.**

There are three salient features to this question. Firstly, widening of the intercondylar notch—this is typically caused by haemophilia and JRA, but can also be caused by tuberculous arthritis. Secondly, causes of arthritis with variable loss of joint space. This is seen in tuberculous arthritis, amyloid, and PVNS, and may be present in haemophilia, although this can also cause severe arthropathy. Thirdly, causes of blooming artefact on GE sequences. This is usually caused by haemosiderin and is found in PVNS and haemophilia. Thus, when the whole picture is considered, the diagnosis is haemophilia.

**18. A 75-year-old man has a cemented right total hip replacement. On routine follow-up imaging he is noted to have a progressive well-delineated, rounded, focal area of lucency at the cement bone interface adjacent to the tip of the femoral stem. Which of the following given reasons is the most appropriate for this progressive lucency?**

- ✓ A. Aggressive granulomatous disease.
- B. Primary loosening.
- C. Cement fracture.
- D. Normal finding.
- E. Metal bead shedding.



**18.A. Aggressive granulomatous disease.**

Well-delineated, rounded, focal areas of lucency at the cement bone interface, which are progressive, are suggestive of either infection or aggressive granulomatous disease. It can occur with both cemented and non-cemented components. Its origin is thought to be multifactorial. Metal, cement, or polyethylene fragments may penetrate the cement bone interface and induce a focal inflammatory foreign-body reaction, leading to osteolysis.

Primary loosening usually manifests as a wide ( $>2$  mm) radiolucent zone at the cement–bone or metal–bone interface or a progressive radiolucent zone at the metal–cement interface. The radiolucent zones are not typically rounded.

Cement fractures are thin linear lucent areas within the cement. They may be asymptomatic, but are important to identify as they may lead to component failure.

Metal bead shedding is defined as opaque microfragments separated from the porous-coated femoral stem. Metal beads can be seen on immediate postoperative radiographs, as a consequence of the stem insertion. Bead shedding might later occur with loose non-cemented components, reflecting micro-motion of the stem. These metal beads are seen in the soft tissue adjacent to the hip replacement and their increase in number on follow-up indicates loosening.

**22. An 18-year-old male patient presents to the rheumatologists with a history of proximal right tibial pain and sternal pain. The patient has a history of psoriasis and is also being seen by the dermatologists with palmoplantar pustulosis. Plain films of the sternum indicate sclerosis of the manubrium and erosive disease in the sternoclavicular joint. Plain films of the tibia show a lucent lesion in the proximal tibial metaphysis with associated periosteal reaction. An MRI shows high signal on STIR in the proximal tibial metaphysis, with a cortical defect. This area enhances on the T1 post gadolinium images, as does the periosteal region. A bone biopsy of the region is negative except for inflammatory cells. What is the most likely diagnosis?**

- A. Psoriatic arthropathy.
- B. Synovitis, acne, pustulosis, hyperostosis, and osteitis (SAPHO) syndrome.
- C. Chronic recurrent multifocal osteomyelitis (CRMO).
- D. Chronic osteomyelitis.
- E. Aseptic necrosis.

**22. B. SAPHO syndrome.**

The most common presentation for this condition is acne and palmoplantarpustulosis with changes in the sternocostoclavicular region where hyperostosis is seen, often with some erosive change. The condition can also cause a number of manifestations in the spine, ranging from focal hyperostosis of one or more lumbar vertebrae, to a syndrome strikingly similar to psoriatic spondylarthropathy. In the appendicular skeleton hyperostosis is commonly seen. SAPHO can also give rise to manifestations identical to osteomyelitis, but with no causative organism. In this respect there is overlap with CRMO syndrome. Patients are frequently human leucocyte antigen (HLA) B27 positive and psoriasis frequently coexists, leading some authors to suggest that SAPHO is a variant of psoriatic arthropathy, although this is not widely accepted.

**25. A 17-year-old female is admitted with multiple penetrating injuries to her arms after shielding her face from a nearby bomb blast while walking in the city centre. For which type of penetrating foreign body is ultrasound most superior for detection?**

- A. Gravel.
- / B. Wood.
- C. Plastic.
- D. Windshield glass.
- E. Bottle glass.

**25. B. Wood.**

Radiography is highly sensitive for foreign bodies considered radio-opaque. All glass material is radio-opaque to some degree on radiographs and does not need to contain lead. The role for ultrasound is limited to those foreign bodies that are radiolucent, such as wood and plastic. Wood appears hyperechoic with marked posterior acoustic shadowing. Ultrasound can detect wooden foreign bodies as small as 2.5 mm in length with 87% sensitivity and 97% specificity. Plastic is also radiolucent, but less echogenic than other foreign bodies on ultrasound.

**26. A 30-year-old female runner presents with a history of pain in the legs on running. Plain radiographs are unremarkable. An isotope bone scan reveals subtle, longitudinal, linear uptake on the delayed bone scan images, with normal angiogram and blood pool images. What is the diagnosis?**

- A. Stress fracture.
- B. Shin splints.
- C. Osteoid osteoma.
- D. Osteomyelitis.
- E. Hypertrophic osteoarthropathy.



**26. B.** Shin splints.

Excessive exertion of tibialis and soleus muscles of the legs causes periostitis along the muscular attachments. This results in longitudinal linear uptake on delayed bone scan images. The angiogram and blood pool images are usually normal compared to stress fracture, which is associated with hyperperfusion and hyperaemia. On delayed images focal fusiform uptake is seen with stress fracture.

Infection is associated with hyperperfusion, hyperaemia, and focal increased uptake.

Osteoid osteoma demonstrates hyperperfusion, hyperaemia, and focal double density due to nidus and reactive osteosclerosis.

Paget's disease is associated with increased uptake in an enlarged and deformed bone. Age and clinical presentation are also against this diagnosis.

Hypertrophic osteoarthropathy is associated with irregular cortical uptake producing the 'tramline' sign.

**33. You are asked to image the pelvis with MRI for someone who has a hip arthroplasty. Which of the following measures can be used to decrease the magnetic susceptibility artifact from the joint prosthesis?**

- A. Use fast spin echo (FSE) imaging rather than GE imaging.
- B. Choose a higher field strength magnet, e.g. 3 T rather than 1.5 T.
- C. Position the long axis of the prosthesis perpendicular to the main magnetic field strength ( $\beta_0$ ) direction if possible.
- D. If fat saturation is to be employed, use spectral fat suppression rather than STIR imaging.
- E. Increase the volume of the voxels (decrease spatial resolution).

**33.A.** Use fast spin echo (FSE) imaging rather than GE imaging.

Magnetization of the implant affects the local field gradient, proton dephasing, and spin frequency, resulting in signal void, spatial distortion, and spurious high signal. The lack of a  $180^\circ$  rephasing pulse in GE sequences, as opposed to SE/FSE sequences, means that  $T2^*$  effects are not reversed and a greater dephasing of spins occurs in GE than in SE/FSE techniques. Thus GE techniques have a greater sensitivity to magnetic susceptibility effects. This is detrimental when imaging patients with metal prostheses, but can be used to advantage in certain clinical situations, e.g. when identifying subtle haemorrhage due to the magnetic susceptibility effects of iron in haemosiderin (a blood breakdown product).

Magnetic susceptibility artefacts are increased with higher field strengths. Positioning the long axis of the prosthesis parallel to the main magnetic field direction ( $\beta_0$ ) reduces susceptibility artefact.

Spectral fat suppression is particularly susceptible to metallic artefact and should be avoided in favour of STIR, where some of the dephasing of proton spins, due to magnetic field inhomogeneity, is refocused by the  $180^\circ$  inversion pulse.

Reducing the number of voxels (increasing spatial resolution) reduces diffusion-related signal intensity loss. It also reduces the spatial definition of the signal void and therefore leads to a reduction in the apparent size of the void.

**34. A patient who is HIV positive presents with knee and ankle pain and swelling. Clinical examination is otherwise unremarkable. Initial radiographs reveal only a joint effusion. The complaint resolves after 4 weeks. What is the most likely diagnosis?**

- A. Septic arthritis.
- B. Psoriatic arthritis.
- C. HIV-associated arthritis.
- D. Acute symmetric polyarthritis.
- E. Hypertrophic pulmonary osteoarthropathy (HPOA).

**34. C.** HIV-associated arthritis.

This is oligoarticular, asymmetric and peripheral. It primarily affects the knees and ankles. It has a short duration of 1–6 weeks; radiography may reveal a joint effusion. Acute symmetric polyarthritis also occurs in HIV. It behaves clinically like RA, but patients are negative for rheumatoid factor. Features that help differentiate it from RA are periostitis and proliferative new bone formation. Occasionally an erosive variety with little or no proliferative bone formation occurs. Psoriatic arthritis has a higher prevalence among AIDS patients than in the general population. HPOA is associated with *P carinii* pneumonia (PCP) in AIDS. Plain films reveal periosteal reaction.

Kaposi's sarcoma uncommonly affects the bone, but does so most commonly in Africa. Non-Hodgkin lymphoma (NHL) is the second most common tumour in HIV infection. It can produce lytic, sclerotic, or mixed lesions with a wide zone of transition; they are usually lytic. Other musculoskeletal complications in AIDS include infections (cellulitis, osteomyelitis, septic arthritis, pyomyositis, necrotising fasciitis), Reiter's syndrome, undifferentiated spondyloarthropathy, polymyositis, osteonecrosis (especially of the femoral head), osteoporosis, rhabdomyolysis, and anaemia.



**36. A 55-year-old female with a history of pulmonary sarcoidosis presents with pain in both hands. Which of the following findings on plain radiograph of the hands is atypical of skeletal sarcoidosis?**

- A. Cyst-like radiolucencies.
- B. Joint space narrowing.
- C. Bone erosions.
- D. Subcutaneous soft tissue nodules/mass.
- E. Lace-like pattern of bone destruction.

**36. B. Joint space narrowing.**

Around 5–10% of patients with sarcoidosis demonstrate skeletal involvement. The phalanges in the hands and feet are most commonly affected.

Joint space narrowing is unusual in sarcoidosis, unless neuropathic changes develop. Typical radiographic changes include cyst-like radiolucencies, a 'lace-like' pattern of bone destruction, bone erosions, and subcutaneous soft-tissue mass. These changes occurring in combination are diagnostic of sarcoidosis.

**42. An 81-year-old male diabetic is referred from the endocrinology team for an MRI of foot. This patient was seeing a podiatrist, who became concerned that the foot had become increasingly deformed and was acutely red and swollen around the tarso-metatarsal joints. The patient is asymptomatic as he has peripheral neuropathy. The clinical query is whether this patient has osteomyelitis/septic arthritis in this region, or neuropathic arthropathy. Which of these MRI features would be more typically associated with osteomyelitis than acute neuropathic arthropathy?**

- A. Focal involvement.
- B. Predominant midfoot involvement.
- C. Associated bony debris.
- D. High T2WI and STIR, low T1WI. Enhancement present.
- E. Bony changes are in a periarticular and subchondral location.

**42. A. Focal involvement.**

Whilst differentiating these conditions can be difficult and they frequently overlap, there are certain features that can be of value. Neuropathic arthropathy (NA) seldom affects a single bone/joint in the foot, and is most common in the midfoot region. As such a more focal abnormality, or abnormality affecting the metatarsal heads, or other points of pressure, should indicate osteomyelitis. Whilst high T2WI/STIR, low T1WI and enhancement are seen in osteomyelitis,

it is also seen in acute NA and as such is not a good differentiating factor. The converse is not true, where low signal on T1WI and T2WI, typical of chronic NA, would make the presence of osteomyelitis unlikely.

**44. A 70-year-old man undergoes an x-ray of his right hand following trauma. There is no evidence of fracture, but incidental resorption of the middle portion of the distal phalanges is demonstrated. Which of the following would be the most likely underlying cause?**

- A. Scleroderma.
- B. Frostbite.
- C. Leprosy.
- D. Polyvinyl chloride.
- E. Psoriatic arthropathy.

**44. D. Polyvinyl chloride.**

This results in resorption of the middle portion of the terminal phalanx. The other answers cause resorption of the terminal tufts of the distal phalanges. Other causes of resorption of the terminal tuft include Raynaud's, diabetes, syringomyelia, burns, trauma, epidermolysis bullosa, congenital phenytoin toxicity (in infants of epileptic mothers), and snake and scorpion venom. Hyperparathyroidism can cause tuft, mid-portion, and periarticular resorption; psoriatic arthropathy can cause tuft and periarticular resorption.

**48. A 34-year-old woman has chronic right wrist pain, with no documented history of previous trauma. An x-ray of the right wrist shows sclerosis and irregularity of the scaphoid with early bony fragmentation. What is the most likely eponymous disease that has resulted in this abnormality?**

- A. Sever disease.
- B. Freiberg disease.
- C. Kohler disease.
- D. Iselin disease.
- ✓ E. Preiser disease.



**48. E. Preiser disease.**

The x-ray appearances are typical for osteonecrosis within the scaphoid. This is usually post-traumatic in aetiology, but when idiopathic it is known as Preiser disease. Postulated mechanisms for the osteonecrosis are repetitive minor trauma or secondary to drug treatment (e.g. steroids).

The remaining wrong answers refer to osteochondroses affecting the foot. Freiberg disease affects the head of the second metatarsal, Kohler disease the tarsal navicular, Iselin disease the base of the fifth metatarsal and Sever disease the calcaneal apophysis.

**51. A 45-year-old female undergoes aggressive chemotherapy for bone metastases followed by bone marrow transplantation. Which of the following findings on MRI indicates recurrent metastatic disease instead of rebound hematopoietic marrow?**

- A. Intermediate signal on T1WI.
- B. High signal on T2WI.
- C. Loss of signal on out-of-phase GE images.
- D. High signal on STIR images.
- E. Increased conspicuity on prolonged time-to-echo (TE) images.

**51. E. Increased conspicuity on prolonged TE images.**

Distinguishing recurrent metastases from rebound hematopoietic marrow is difficult on standard T1WI and T2WI sequences because both have intermediate signal intensity on T1WI and high signal intensity on T2WI. They may also occur in same anatomic regions.

Out-of-phase GE imaging is useful in differentiating the two. Most neoplastic processes replace the marrow elements such as fat, osseous trabeculae, and hematopoietic elements, but hyperplastic red marrow does not. Out-of-phase imaging allows detection of intralesional fat by demonstrating a drop in signal intensity compared to in-phase images.

Lengthening of echo results in loss of signal of rebound red marrow due to T2\* dephasing, while the water-laden metastatic foci become more conspicuous.

**54. An 18-year-old male with fingernail dysplasia and a family history of renal failure is investigated for possible nail-patella syndrome. Which of the following radiographic findings is considered pathognomonic for this disorder?**

- A. Patellar hypoplasia.
- B. Lateral elbow hypoplasia.
- C. Posterior iliac horns.
- D. Calcaneo-valgus feet.
- E. Madelung deformity.

**54. C.** Posterior iliac horns.

Nail-patella syndrome (hereditary onycho-osteodysplasia) is an autosomal dominant condition characterized by nail dysplasia, patella hypoplasia, elbow hypoplasia, and iliac horns. Iliac horns are present in over 80% of patients and are considered pathognomonic. They arise at the site of gluteus medius and project posterolaterally. Patella hypoplasia results in chronic knee pain and recurrent dislocations. Elbow hypoplasia is typically towards the lateral side of the joint. Madelung deformity and calcaneo-valgus feet are other features described in nail-patella syndrome. The most important non-orthopaedic condition is an immune complex nephropathy, which can result in end-stage renal failure. These patients are also at risk of open-angle glaucoma.

**55. A 10-year-old male involved in an RTA is brought to the A&E department with a history of severe right thigh pain. Plain radiograph demonstrates a transverse fracture in the mid-diaphysis of the femur. Incidental note is made of bone osteopenia and undertubulation of the femur with metaphyseal flaring producing Erlenmeyer flask deformity and coxa magna related to previous avascular necrosis of the femoral head. What is the underlying bone disease?**

- A. Pyle's disease.
- B. Osteopetrosis.
- C. Gaucher's disease.
- D. Fibrous dysplasia.
- E. Ollier's disease.

**55. C. Gaucher's disease.**

All these conditions cause Erlenmeyer flask deformity and are associated with pathological fractures. However, the history of previous avascular necrosis of femoral head suggests Gaucher's disease. Sickle-cell disease (SCD) may also cause all the above bone changes.

Gaucher's disease is a rare familial metabolic disorder caused by deficiency of the enzyme  $\beta$ -glucocerebrosidase. This leads to accumulation of glucocerebroside in reticuloendothelial cells (macrophages) of the liver, spleen, and bone marrow.

The imaging findings include delayed growth, osteopenia, Erlenmeyer flask deformity, metaphyseal notching of humeri, bone infarction/avascular necrosis, and pathological fractures. Diffuse marrow replacement with low signal on T1WI is noted on MRI. Visceral manifestations include hepato-splenomegaly and reticulonodular interstitial lung disease.

**56. A 45-year-old female is being investigated. She has a history of connective tissue disease. You are reviewing her imaging and trying to decide which connective tissue disease she has. Her hand x-rays reveal distal tuft resorption with cutaneous calcification. She also has erosion of the distal IP joints in the hands and the first carpometacarpal (CMC) joint. She has ulnar deviation deformity to the MCP joints in both hands on the Norgaard views, which corrects on the antero-posterior (AP) views. She also has an MRI scan of the pelvis which shows uniform high T2WI signal in the gluteal muscles bilaterally. From the list of connective tissues diseases below, select the one paired with a feature that is atypical for the disease but present in this patient?**

- A. Systemic sclerosis and high signal changes in muscles
- B. SLE and deforming arthropathy
- C. Systemic sclerosis and acro-osteolysis
- D. Polymyositis and erosive arthropathy
- E. Polymyositis and soft tissue calcification



**56. D. Polymyositis and erosive arthropathy.**

There is a lot of overlap in the features of connective tissue diseases, with a number of patients labelled as mixed-connective tissue disease due to this. There are features of these conditions that can help differentiate them. SLE is a great mimic and can manifest in a myriad of ways. Erosive disease is not typically seen in SLE, but SLE does classically give a reducible deforming arthropathy of the hands, which is most pronounced on Norgaard views, but can appear completely normal on PA hand views. Avascular necrosis (AVN) and deforming arthropathy are not typically seen in systemic sclerosis. Acro-osteolysis and soft-tissue calcifications, especially in the fingertip pulps, are classical features of this disease. Polymyositis classically gives high T2WI signal in muscles due to myositis. It does not typically give erosions.

**59. A 34-year-old man is admitted with sudden onset chest pain described as tearing in nature. Clinical examination reveals a diastolic murmur consistent with aortic regurgitation. Subsequent chest CT confirms ascending aortic dissection. He has a past medical history of spontaneous pneumothorax. Despite a negative family history, an underlying diagnosis of Marfan syndrome is suspected. Which of the following musculoskeletal manifestations is required for this diagnosis to be made?**

- A. Joint hypermobility.
- B. Pectus excavatum of moderate severity.
- C. Reduced upper-to-lower segment ratio.
- D. High arched palate.
- E. Malar hypoplasia.

**59. C. Reduced upper-to-lower segment ratio.**

Marfan syndrome is an autosomal dominant multisystem connective tissue disorder, but approximately 25% are sporadic mutations. Mutation of the fibrillin-1 gene is the underlying genetic abnormality. There is a broad phenotype expression, although diagnosis can be made clinically based on the presence of major and minor features as per the Ghent classification system. In the absence of a family history, the presence of two major criteria in two different organ systems and a minor criterion in a third system supports a diagnosis of Marfan syndrome. In this case, dissection of the ascending aorta is a major cardiovascular criterion and spontaneous pneumothorax a minor pulmonary system criterion. Of the musculoskeletal manifestations, reduced upper-to-lower segment ratio is a major criterion, the remaining options are all minor criteria. Other musculoskeletal system major criteria include scoliosis with a curvature greater than 20°, pectus carinatum, pectus excavatum requiring surgery, acetabular protrusion, and medial displacement of the medial malleolus causing pes planus.

**60. A 25-year-old marathon runner presents with a history of right calf pain during exercise. Popliteal artery entrapment is suspected clinically. Which of the following statements regarding imaging of popliteal artery entrapment syndrome (PAES) is true?**

- A. In PAES, the popliteal artery is compressed with the ankle in the neutral position.
- B. A normal Doppler ultrasound of the popliteal artery excludes the diagnosis.
- C. In the normal popliteal fossa, the popliteal artery and vein pass lateral to the medial head of the gastrocnemius and are surrounded by fat.
- D. The anatomical abnormality is invariably unilateral.
- E. Catheter angiography is the gold standard for the diagnosis.

**60. C.** In the normal popliteal fossa, the popliteal artery and vein pass lateral to the medial head of the gastrocnemius and are surrounded by fat.

Popliteal artery entrapment syndrome is a developmental abnormality resulting from an abnormal relationship between the popliteal artery and neighbouring muscles. It is commonly seen in healthy young adults and can present with symptoms of intermittent claudication or thromboembolism. The anatomical abnormality occurs bilaterally in 27–67%.

The popliteal vessels normally pass lateral to the medial head of gastrocnemius. An anomalous origin of the medial head or an anomalous course of the popliteal artery may result in extrinsic compression of the artery.

Doppler and digital subtraction angiography (DSA) findings may be non-specific with a wide spectrum of findings. A normal Doppler or DSA with neutral ankle position does not exclude the diagnosis. Provocative measures with ankle dorsiflexion and plantar flexion may be useful in confirming the diagnosis on Doppler and DSA, but they do not demonstrate the underlying anatomical cause. Non-invasive assessment with CT angiogram or MR angiogram is preferred as they also demonstrate the anatomical abnormality.

**63. A 62-year-old male with a known diagnosis of bronchogenic carcinoma presents with pain and swelling of his wrists. What radiographic features are consistent with hypertrophic pulmonary osteoarthropathy?**

- ☒ A. Metaphyseal lamellar periosteal reaction.
- B. Irregular epiphyseal periosteal proliferation.
- C. Asymmetrical, thick 'feathery' periosteal reaction.
- D. Cortical thickening and trabecular coarsening.
- E. Symmetrical, solid periosteal new bone formation.



**63.A. Metaphyseal lamellar periosteal reaction.**

Hypertrophic pulmonary osteoarthropathy is a paraneoplastic syndrome secondary to the release of vasodilators. It typically causes burning pain and swelling, with the ankles and wrists being most commonly affected. Pulmonary causes include bronchogenic carcinoma, mesothelioma, and pleural fibroma. Radiographs demonstrate cortical thickening and lamellar periosteal proliferation in a diaphyseal location. Bone scintigraphy will demonstrate patchy linear increased uptake along the cortical margins. Option B describes pachydermoperiostosis, a self-limited condition in adolescents. Option C is typical of thyroid acropachy. Cortical thickening and trabecular coarsening is a feature of Paget's disease and symmetrical, solid periosteal new bone formation is described in hypervitaminosis A.

**64. A 57-year-old female patient with a history of multiple myeloma is referred for imaging due to a history of arthralgia primarily affecting the hands. The patient describes early morning stiffness that eases through the day. The clinicians report a finding of synovitis clinically. Blood results have revealed a raised ESR. Hand x-rays are carried out which reveal sharply defined intra-articular marginal erosions at the MCP joints of the index and middle fingers bilaterally. The joint spaces are well preserved. There are also well-marginated subchondral cysts noted in the carpal bones, again with joint space preservation. Soft tissue nodules are noted around the wrist joints, which are not calcified. There is no evidence of juxta-articular osteopenia. No osteophytes are noted. What diagnosis is most strongly suggested by these findings?**

- A. Gout.
- B. CPPD.
- C. RA.
- D. Amyloidosis.
- E. Wilson's disease.

**64. D. Amyloidosis.**

There are a lot of conditions that are capable of mimicking RA. In these cases a few key features can help reach a diagnosis. The classic finding in gout is of non-marginal erosions, as opposed to those described. Nevertheless, marginal erosions can occur with gout. An RA-type picture in the presence of non-marginal erosions or calcified soft-tissue nodules (tophi) should suggest this diagnosis. CPPD gives a more productive pattern of arthritis, such as seen with OA, affecting the radio-carpal joint. Thus, it is often suspected when the appearance is of OA with a 'funny distribution'. Amyloidosis is suggested first by the history of MM. Involvement of the hands is more commonly seen in amyloid secondary to prolonged dialysis, but can be seen when the amyloid is secondary to MM, when the wrists are often affected. Amyloid can closely resemble RA in its distribution and the pattern of erosions. However, three important features can help differentiate: amyloidosis classically preserves the joint space, is not usually associated with periarticular osteopenia, and amyloidosis causes well-demarcated subchondral cyst formation in excess to that expected from the degree of joint disease.

**67. A 22-year-old patient presents to casualty with a reduced GCS and hypotension. He is visiting the UK from abroad and fellow backpackers in a local youth hostel state that he was complaining of abdominal pain earlier that day. A CT abdomen reveals sclerosis in both femoral heads and H-shaped vertebrae. The spleen is small and calcified. What is the patient's most likely underlying diagnosis?**

- A. Scheuermann's disease.
- B. Hereditary spherocytosis.
- C. Gaucher disease.
- D. Sickle-cell disease.
- E. Primary bone lymphoma.

**67. D. Sickle-cell disease.**

Gaucher disease and SCD can both cause H-shaped vertebrae and avascular necrosis of the humeral heads, but Gaucher disease causes splenomegaly, whereas by adulthood SCD will usually have caused splenic infarction, resulting in a small, calcified spleen. Films illustrating the complications of these diseases are beloved by examiners in the 2B exam: remember to look for the mediastinal mass (extramedullary haematopoiesis) and AVN of the proximal humeri on the chest film.

Other musculoskeletal manifestations of SCD include osteomyelitis (particularly *salmonella* species), septic arthritis, and medullary bone infarcts. Infarction in SCD is common throughout the body and is responsible for the acute pain crisis. Infarction can occur in the liver, spleen, and kidneys, and can result in stroke.

Scheuermann's disease is osteochondrosis of the apophyses of the thoracic vertebrae and results in end-plate irregularity, Schmorl's nodes, loss of disc space, and kyphosis. True H-shaped vertebrae are not a feature.

Hereditary spherocytosis is an autosomal dominant condition. It produces splenomegaly and, as with other haematological conditions, can result in widening of the diploic spaces of the skull.

Primary bone lymphoma typically appears as a solitary focal lesion with an aggressive appearance.

**68. A 41-year-old male presents to the A&E department with knee pain following a fall at work. Plain radiography does not demonstrate any fracture, but note is made of continuous, irregular cortical hyperostosis along the lateral margin of the femur. What is the most likely diagnosis?**

- A. Osteopoikilosis.
- B. Fibrous dysplasia.
- C. Engelmann disease.
- D. Melorheostosis.
- E. Osteopathia striata.

**68. D. Melorheostosis.**

The radiographic findings describe the 'flowing candle-wax' sign, which indicates melorheostosis, a non-hereditary sclerosing bone dysplasia of unknown aetiology. Patients are often asymptomatic, being discovered incidentally. It is most common in the long bones. The disease can overlap with other sclerosing bone dysplasias such as osteopoikilosis (multiple ovoid bone islands) and osteopathia striata (metaphyseal longitudinal striations). Engelmann disease presents in childhood with neuromuscular dystrophy. Diaphyseal fusiform enlargement with cortical thickening is seen in the long bones. Fibrous dysplasia causes bone thinning.



**70. An orthopaedic surgeon in your hospital comes to your office to ask your advice on a 15-year-old girl he is about to see at his clinic. Although limited clinical information is available, he was able to find out that the patient has a congenital condition, which has resulted in her being confined to a wheelchair. As she was complaining of a sore knee, an x-ray was carried out. There is a long gracile femur and tibia, indicating undertubulation of the bone. What is the most likely cause for this appearance?**

- A. Dwarfism.
- B. Gaucher's disease.
- ✓ C. Cerebral palsy.
- D. Arthrogryposis multiplex congenital.
- E. Juvenile RA (JRA).

**70. C. Cerebral palsy.**

As a radiologist you would obviously have been able to correct your orthopaedic colleague, that long gracile bones are examples of overtubulation, not undertubulation. As such options A, B, and E are not diagnostic considerations as these result in undertubulation and may cause an Erlenmeyer flask abnormality. This phenomenon is further described elsewhere in this chapter, but causes of Erlenmeyer flask abnormality include anaemias (thalassaemia, SCD), storage disorders (Gaucher's, Niemann–Pick), and skeletal dysplasias (Pyle's disease, craniometaphyseal dysplasia, Melnick–Needles syndrome).

The most common cause of over-tubulation is in patients with diminished weight bearing (cerebral palsy, myelomeningocele, arthrogryposis), with cerebral palsy being the most common of these. JRA and Marfan syndrome can also cause this appearance.

**72. A 21-year-old patient attends the A&E department following a minor injury with a suspected fracture. The request form states that the patient has osteogenesis imperfecta. It is noted that the patient is of reduced stature and does not display any evidence of blue sclera, but that the colouration of his sclera has faded over time. He has normal hearing. What subtype of osteogenesis imperfecta does he likely have?**

- A. Type I.
- B. Type II.
- C. Type III.
- D. Type IV.
- E. Type V.

**72. D. Type IV.**

Osteogenesis imperfecta in an adult is almost always type I or IV. Type I is the most common. Patients have can have normal stature and the characteristic blue sclera are seen in 90%. Patients also often have hearing impairment. Type IV has variable bone fragility, from mild to severe. Hearing impairment is less common, as is reduced stature. Blue sclera are present in children, but are often absent after adolescence. Type II is universally fatal in the neonatal period. Type III is also severe and often associated with reduced lifespan. Stature is significantly reduced. In patients who survive to adolescence the blue sclera are also often absent. Type V is not universally recognized, but is similar to type IV.

**73. A radiologist is reporting a  $^{99m}\text{Tc}$  bone scan and describes it as a 'superscan'. He can say this because of reduced uptake in the:**

- A. brain
- B. skeleton
- C. kidneys
- D. bowel
- E. myocardium.

**73. C. Kidneys**

A superscan refers to a  $^{99m}\text{Tc}$ -labelled technetium IBS where there is diffuse increased osseous uptake with *apparent* reduced renal and soft tissue uptake. The appearance is commonly due to widespread osteoblastic bony metastases (e.g. prostate or breast carcinoma), but is also caused by non-malignant disease (e.g. renal osteodystrophy, hyperparathyroidism, osteomalacia, myelofibrosis, Paget's disease). In metastatic disease there is usually higher uptake in the axial than the appendicular skeleton.

In IBS uptake is normally seen in bone, kidneys, and bladder; soft tissues (low levels), breasts (particularly in young women), and epiphyses (skeletally immature patients). Uptake is seen in the myocardium (high), brain (high), and bowel (moderate) in FDG-PET scanning, not IBS; however myocardial uptake on IBS can be seen in cases of recent myocardial infarction and amyloidosis. Note that poor renal function can often demonstrate reduced or absent renal visualization producing an appearance similar to a superscan (false positive), whereas urinary tract obstruction in prostatic carcinoma can increase renal activity and lead to false negative scans.



**74. You are reviewing the x-rays of a child that are stored in your department's museum. Sequential radiographs have been taken as the child has aged and the appearances have become more pronounced with time. The child has a form of dwarfism. On the CXR you notice 'oar-shaped' ribs. The metacarpals are short and wide, but narrow proximally, giving a fan-like appearance. The patient has a J-shaped sella turcica. The iliac wings are wide, but the iliac bones narrow inferiorly. On the lateral lumbar spine, the vertebra have central anterior beaks. A clinical vignette mentions that the patient was not intellectually impaired. What condition does the patient probably have?**

- A. Campomelic dysplasia.
- B. Niemann–Pick disease.
- C. Morquio syndrome.
- D. Achondroplasia.
- E. Hurler's syndrome.

**74. C. Morquio syndrome.**

The constellation of skeletal manifestations describes the characteristic appearance of dyostosis multiplex. This pattern of skeletal abnormalities is seen with the mucopolysaccharidoses (MPS), although it can also be seen with other storage disorders. With the exception of Hurler's syndrome, where the manifestations are present at 1 year of age, the skeletal manifestations progress as the patients get older. Hurler's and Morquio's are the most common of the MPS conditions. Amongst the MPS conditions, Morquio's stands out as a favourite for single best answer (SBA) and viva questions as it is the only MPS where the patient is not intellectually impaired. It also displays a central anterior vertebral body beak, whereas the other conditions have an anterior beak in the lower third of the vertebral body.

The differences with achondroplasia are the progression with age and the pelvic shape. The pelvis in achondroplasia has widened iliac wings, with horizontal acetabular roofs and a narrow inlet, giving the classic 'champagne glass' appearance. The anterior beak in achondroplasia is also in the lower third of the vertebral body.

- 5 A CXR is performed in a patient with increasing shortness of breath. The lungs are clear, but there is a bilateral symmetrical absence of the lateral end of the clavicles.**

**Which is the least likely cause of these appearances?**

- (a) Cleidocranial dysplasia
- (b) Eosinophilic granuloma
- (c) Hyperparathyroidism
- (d) Pyknodysostosis
- (e) Rheumatoid arthritis

**5 (b)**

Other causes include trauma, infection, metastases and myeloma (but these are less likely to be bilaterally symmetrical). EG is a cause of destruction of the medial end of the clavicle, which can also be caused by metastases, infection, lymphoma and rheumatoid arthritis.

- 6 A 45 year old man has an acute episode of shortness of breath. A CXR is requested; this shows concave scalloping of the undersurface of the right 2nd and 3rd ribs, there is a slight scoliosis of the inferior aspect of the thoracic spine, but the lung parenchyma is clear.**

**Which of the following is the most likely cause of these appearances?**

- (a) Marfan's syndrome
- ✓ (b) Neurofibromatosis Type I
- (c) Rheumatoid arthritis
- (d) SLE
- (e) Scleroderma

*The other cause superior rib notching*

*Inferior rib notching is caused by vascular origin*

**6 (b)**

The other listed diagnoses would be expected to cause superior rib notching. Superior notching is typically caused by connective tissue disorders, inferior notching is typically of vascular origin due to enlarged collateral vessels: coarctation, interrupted aortic arch, subclavian stenosis (Takayasu's), or SVC obstruction with venous collaterals, or AVMs. Hyperparathyroidism and NF-I can cause superior or inferior rib notching, the latter diagnosis is further suggested by the presence of scoliosis.

**7 Which of the following forms of micromelic dwarfism is considered to be the most severe?**

- (a) Diastrophic dysplasia
- (b) Heterozygous achondroplasia
- (c) Nievergelt syndrome
- (d) Osteogenesis Imperfecta Type 1
- ✓ (e) Thanatophoric dysplasia

**7 (e)**

Thanatophoric dysplasia is the commonest type of lethal micromelic dwarfism. Features include clover-leaf skull (15%), limb bowing, narrow thorax, non-immune hydrops. Other lethal dwarfisms include camptomelic dysplasia, Ellis-van Creveld syndrome, Jeune's syndrome, achondrogenesis, hypophosphatasia, homozygous achondroplasia, OI Type 2, and chondrodysplasia punctata. Heterozygous achondroplasia, OI Types 1, 3 and 4, diastrophic dysplasia, and Nievergelt syndrome are non-lethal variants.

- 
- 14 A patient presents with painful swelling of the limbs and joints, particularly the knees, ankles, wrists and elbows. Digital clubbing and joint effusions are noted. Plain radiographs show marked bilateral, smooth periosteal reactions affecting the radius, ulna, tibia and fibula.

**Which one of the following diseases is not associated with the most likely unifying condition?**

- (a) Gaucher's disease
- (b) Carcinoma of the bronchus
- (c) Undifferentiated nasopharyngeal carcinoma
- (d) Pleural fibroma
- (e) Ulcerative colitis

**14 (a)**

The patient is most likely to be suffering from hypertrophic osteoarthropathy. This is commonly secondary to disease within the chest but many extra-thoracic causes are also recognised. Possible thoracic causes include: Bronchogenic carcinoma, lymphoma, pulmonary metastasis, a benign tumour (e.g. pleural fibroma), and chronic inflammation/infection (e.g. an abscess, bronchiectasis). Extrathoracic causes include, amongst others: inflammatory bowel disease, whipple's disease, coeliac disease, cirrhosis, dysentery and undifferentiated nasopharyngeal carcinomas.

- 25 A 32 year old presents with acute abdominal pain. An AXR demonstrates calcification in the LUQ, with loops of bowel in this region, central depressions in the superior and inferior endplates of L3 and L4, and a mixed lysis/sclerosis appearance to the superior aspect of the left femoral head.

What is the likely unifying diagnosis?

- (a) Achondroplasia
- (b) Hyperparathyroidism
- (c) Lymphoma
- (d) Renal osteodystrophy
- ✓ (e) Sickle cell disease

H-shaped vertebrae

AVN of femur

auto-infarction of spleen

hair on end appearance to the skull

osteomyelitis

25 (e)

The described findings are of an H-shaped vertebrae (often better appreciated on lateral films), left femoral head AVN, and auto-infarction of the spleen. In SCD, the Hb deforms at low oxygen tension, and obstructs small blood vessels, leading to hypoxia/ anoxia (AVN), and splenic auto-infarction (on AXR: prominent bowel loops in the LUQ +/- calcification of the spleen). Other skeletal features include 'hair-on-end' appearance to the skull, secondary osteomyelitis (often due to *Salmonella*), and premature epiphyseal fusion. Cholelithiasis, cardiomegaly, PE, cerebral infarcts, and renal papillary necrosis are also associated.



- 27 Axial MR imaging of the ankle is performed. You are asked to review a single image at the level of the tibio-talar joint. You note a tendon which is swollen and contains unusually high signal, located immediately posterior to the tendon of tibialis posterior.**

**What is the likely diagnosis?**

- (a) Tendonitis of extensor hallucis longus
- (b) Tendonitis of extensor digitorum longus
- (c) Tendonitis of flexor hallucis longus
- (d) Tendonitis of flexor digitorum longus
- (e) Tendonitis of tibialis anterior

**27 (d)**

The flexor tendons occur in the order (from anterior to posterior): tibialis posterior, flexor digitorum longus, flexor hallucis longus – the mnemonic 'Tom, Dick, and Harry' aids memory.

- 30 You are asked to review a hand x-ray of a 6 year old boy. The request simply states "Please assess bone age", there are no prior films available for comparison. There is osteopaenia and mild expansion of the medullary cavities of all the metacarpals and phalanges. There is additional atrophy of the trabeculae and cortical thinning.**

**What is the likely diagnosis?**

- (a) Engelmann's disease
- (b) Hurler's syndrome
- (c) Ollier's disease
- (d) Pseudo-pseudohyperparathyroidism
- (e) Thalassaemia

**30 (e)**

The earliest changes of thalassaemia can be seen in the small bones of the hand and feet. The appearances described are due to marrow hyperplasia secondary to anaemia. The changes are typically symmetrical with osteopaenia/osteoporosis, atrophy and coarsening of the trabeculae, widening of the medullary spaces, and thinning of the cortices.

**42 A patient with Paget's disease has a series of plain radiographs.**

**Which of the following is a feature of the active phase of the disease?**

(a) Widened and coarsened trabeculation of the pelvic ring

(b) 'Cotton wool' skull

(c) 'Ivory vertebra'

(d) Osteoporosis circumscripta *and well-defined "flame-shaped" radiolu-  
w/ thin long bones*

(e) Splitting of the iliopectineal line

**42 (d)**

The active phase is the osteolytic phase, also known as the 'hot' phase. Typical lesions include osteoporosis circumscripta of the skull (especially frontal and occipital bones) and well-defined, 'flame-shaped' radiolucencies of the long bones.

- 46 A child presents with bruising and a tibial fracture. The possibility of non accidental injury is raised.

Which of the following statements with regards to NAI is incorrect?

- (a) Metaphyseal 'corner' fractures are the commonest fracture type *— less common than distal humerus # but high specific*
  - (b) Multiple fractures at different stages of healing is a highly specific sign
  - (c) Skull fractures are seen in 20% of cases
  - (d) Interhemispheric haemorrhage is the commonest site of intracranial haemorrhage
  - (e) Exuberant callus formation is a feature
- 50 A 3 month old infant presents with tender, hard swellings over a number of bones. Radiographs reveal a cortical hyperostosis and marked, diffuse, symmetrical periosteal reaction of the clavicles, ribs and mandible.

Which of the following is the most likely diagnosis?

- (a) Rickets
- (b) Caffey's disease *= infantile cortical hyperostosis*
- (c) Hypothyroidism
- (d) Scurvy
- (e) Ulcerative colitis

50 (b)

The appearances are typical of Caffey's disease, also known as infantile cortical hyperostosis. Scurvy and rickets are unlikely to produce this picture in those < 6 months old.

- 6 You review a series of plain radiographs of a male patient taken over the course of 25 years. There is irregular, solid, bilateral, symmetrical periosteal proliferation of the distal long bones. These appearances developed in his adolescence, and have been stable since. You are told that this is relatively pain-free.**

**What is the most likely diagnosis?**

- (a) Pachydermoperiostitis
- (b) Diffuse idiopathic skeletal hyperostosis
- (c) Fluorosis
- (d) Secondary hypertrophic osteoarthropathy
- (e) Vascular insufficiency

**6 (a)**

Pachydermoperiostosis, also known as primary hypertrophic osteoarthropathy, is an autosomal dominant condition resulting in a bilateral, symmetrical periosteal reaction of the distal long bones. This typically develops in young men and spontaneously arrests in adulthood. Compared to secondary hypertrophic osteoarthropathy, the periosteal reaction is more solid and relatively painless.

- 9 The radiographs of an elderly patient demonstrate the expansion of a long bone, with cortical bone thickening and coarse trabeculation. Paget's disease is suspected. Further investigations were performed in the nuclear medicine department.**

**Which of the following is not typical?**

- (a) Marginal uptake of  $^{99m}\text{Tc}$ -MDP in lytic lesions
- (b) Deformity of bones
- (c) Normal uptake of  $^{99m}\text{Tc}$ -MDP in some sclerotic lesions
- (d) Increase uptake of  $^{99m}\text{Tc}$ -MDP in the active phase
- (e) Increased uptake of  $^{99m}\text{Tc}$ -sulphur colloid by bone marrow

**9 (e)**

Uptake of  $^{99m}\text{Tc}$ -sulphur colloid is reduced due to the replacement of bone marrow by fibrovascular tissue.

**15 A patient with a hereditary haemoglobinopathy has multiple skeletal abnormalities evident from his plain radiographs.**

**Which feature is typically more marked in sickle-cell anaemia than thalassaemia major?**

- (a) 'Hair-on-end' appearance of the skull
- (b) Obliteration of the paranasal sinuses
- (c) 'Erlenmeyer flask' deformity of the long bones
- (d) Square-shaped compression infarcts of the vertebral end plates
- (e) Widening of the skull diploe

**15 (d)**

Marrow hyperplasia and extramedullary haematopoiesis are less severe in sickle-cell anaemia than thalassaemia major, and may not be evident on radiographs. The 'hair-on-end' appearance, obliteration of the paranasal sinuses, 'Erlenmeyer flask' deformity and widening of the skull diploe are all more common in thalassaemia major. Square shaped compression infarcts of the vertebral end plates are virtually diagnostic of sickle-cell anaemia.



- 27** You are reporting plain films from the outpatient clinic. A request states "...chronological age 6 years, please assess bone age". The film shows the fingers are nearly equal in length and are divergent at the first interphalangeal joint, leading to a separation of the 2nd and 3rd digits.

**What is the underlying diagnosis?**

- (a) Achondroplasia
- (b) Down's syndrome
- (c) Holt-Oram syndrome
- (d) Hurler's syndrome
- (e) Morquio's syndrome

**27 (a)**

The findings described are those of a 'trident' hand which is seen in achondroplasia.

- 33** A 14 year old boy has a CXR which shows clear lungs, no cardiomegaly, an indistinct right heart border, decreased heart density and leftward displacement of the heart.

**Which of the following conditions is not associated with these findings?**

- (a) Prematurity
- (b) Down's syndrome
- (c) Noonan's syndrome
- (d) Marfan's syndrome
- (e) Homocystinuria

**33 (c)**

These findings are those of pectus excavatum which is most usually an isolated abnormality, but in addition to the above is also associated with foetal alcohol syndrome. Other radiological signs include a horizontal course of the posterior portion of the ribs along with an accentuated downward course of the anterior ribs.

- 38 A teenager presents with recurrent patella dislocations. Radiographs reveal hypoplastic patellae and bilateral posterior iliac horns.**

**Which of the following is an unlikely association?**

- (a) Renal dysfunction
- (b) Short 5th metacarpal
- (c) Hypoplastic radial head
- (d) Scoliosis
- (e) Hypoplastic recessed anterior iliac spines

**38 (e)**

Nail-patella syndrome (also known as Fong's disease) is described. This is a rare autosomal dominant disorder characterised by symmetrical meso- and ecto-dermal anomalies. Bilateral posterior iliac horns (seen in 80%) are diagnostic. Renal dysfunction is the commonest serious complication. A flared iliac crest with protuberant anterior iliac spines are seen.

- 39 A 56 year old man presents with weight loss, skin changes and sensory symptoms. He is found to have a polyneuropathy, and areas of hyperpigmentation and thickening of the skin. A CT is requested which gives the clinical details and also states "...?paraneoplastic phenomenon, ?scleroderma, ?POEMS syndrome".**

**Which two features at CT support the diagnosis of POEMS syndrome?**

- (a) Eosinophilic granuloma and hepatosplenomegaly
- (b) Eosinophilic granuloma and multiple exostoses
- (c) Hepatosplenomegaly and plasmacytoma
- (d) Multiple exostoses and synovitis
- (e) Plasmacytoma and synovitis

**39 (c)**

POEMS syndrome (Polyneuropathy, Organomegaly, Endocrinopathy/Edema, Monoclonal gammopathy, and Skin changes) is a rare multi-systemic disease. There may be an overlap with Castleman's disease. All patients have a polyneuropathy; most authors state that a minimal of 3 of the listed features need to be present for diagnosis. There is usually a plasma cell dyscrasia: most have osteosclerotic myeloma, plasmocytomas and/ or a monoclonal gammopathy of unknown significance. Skin changes include hyper-pigmentation, hypertrichosis, plethora, and haemangiomas.

- 42 A 33 year old sportsman presents with knee pain following a twisting injury. He has previously had a stainless steel screw in his knee as a result of reconstructive surgery of the anterior cruciate ligament, and the orthopaedic team request an MR examination of the knee for further assessment. You consider techniques that can be employed to reduce artefact from the metal.**

**Which of the following will actually increase the artefact?**

- (a) Utilising fast spin echo sequences rather than conventional spin echo sequences
- (b) Utilising STIR sequences rather than spectral fat saturation sequences
- (c) Use of a high resolution matrix
- (d) A decrease in the echo train length
- (e) Imaging with a 3.0 Tesla magnet rather than a 1.5 Tesla magnet

**42 (e)**

A small field of view, high gradient strength and thin sections reduce artefact as does the use of a lower strength magnet.

- 44 A child presents with knee pain, without a history of trauma. Plain radiographs of the knee demonstrate expansion of the distal end of the femur.**

**Which of the following do not cause this appearance?**

- (a) Hyperphosphatasia
- (b) Fibrous dysplasia
- (c) Gaucher's disease
- (d) Pyle disease
- (e) Osteopetrosis

**44 (a)**

There is a wide differential diagnosis for the 'Erlenmeyer flask' deformity. This includes hypophosphatasia, rheumatoid arthritis, leukaemia, achondroplasia, sickle cell disease, thalassaemia, rickets and Down's syndrome.

- 46 A 65 year old man has a pelvic X-ray following a fall. No fracture is identified. However, incidental note is made of thickening of the trabeculae in the ilium along with acetabular protrusion and thickening of the iliopectineal line.**

**Which of the following features are not seen in this condition?**

- (a) Picture frame vertebra
- (b) Ivory vertebra
- (c) Diploic widening of skull
- (d) 'Cotton wool' appearance of the skull
- (e) 'Hair-on-end' appearance of skull

**46 (e)**

The exact appearance of Paget's disease depends on which phase it is in (active, mixed or quiescent). It may be complicated by malignant degeneration, fracture or neurological entrapment. 'Hair-on-end' appearance is seen in thalassaemia, hereditary spherocytosis and sickle cell disease amongst others.

- 48 An infant has an incidental finding of bone within bone appearance within the thoracic vertebrae.**

**Which of the following is not a recognised cause of this appearance?**

- (a) Gaucher's disease
- (b) Normal variant
- (c) Caffey's disease
- (d) Osteopetrosis
- (e) Melorheostosis

**48 (e)**

Other differential diagnoses include sickle cell, thalassaemia, congenital syphilis and acromegaly.

- 54 A wrist radiograph in a child demonstrates a carpal angle of 110°.**

**Which of the following is not a recognised cause?**

- (a) Hurler's syndrome
- (b) Down's syndrome
- (c) Madelung deformity
- (d) Turner's syndrome
- (e) Morquio's syndrome

**54 (b)**

The carpal angle is formed by two tangential lines, the first drawn between the proximal scaphoid and lunate, and the second between the triquetrum and lunate. It has a normal range of 130–137° in the adult and normal ranges have been derived for children of different ages. Down's syndrome is associated with an increased carpal angle (>139°) along with other conditions such as arthrogryposis.



- 57 A 34 year old woman is found to have bilateral hilar lymphadenopathy on CXR along with elevated serum ACE levels.**

**Which of the following radiological features would not be in keeping with the likely diagnosis?**

- (a) Acro-osteolysis of the distal phalanges
- (b) Erosions involving the joints of the hand
- (c) A lacelike trabecular pattern in the metaphysis of the metacarpals
- (d) More advanced changes in the middle and distal phalanges than the proximal phalanges and the metacarpal bones
- (e) Sclerosis of multiple vertebral bodies

**57 (b)**

The joints are rarely involved in bone sarcoidosis. Other musculoskeletal features include the presence of paravertebral soft tissue masses, osteolytic lesions of the skull and well defined cystic bone lesions.

- 58 A 30 year old patient presents with multiple bilateral renal angiomyolipomas, one of which has bled. She is also found to have a giant cell astrocytoma in her brain and bilateral interstitial lower lobe fibrosis on CXR.**

**Which of the following bone lesions is most commonly associated with this condition?**

- (a) Bone cysts
- (b) Osteochondroma
- (c) Giant cell tumour
- (d) Fibrous dysplasia
- (e) Adamantinoma

**58 (a)**

The underlying condition described is tuberous sclerosis. The associated bone cysts most commonly affect the small bones of the hand. Other skeletal features include sclerotic bone islands which most commonly affect the calvarium (in 45% of cases) and also the pelvis and long bones.

**59 A 27 year old man presents with ongoing pain in the region of the sternum. There is no history of trauma. On examination there is tenderness, pain and swelling over the sternoclavicular joints; he is systemically well but is noted to have yellowish intradermal blisters on his hands. There is sclerosis and ankylosis of the right SCJ, with hyperostosis and hypertrophy of the left SCJ noted.**

**What is the likely diagnosis?**

- (a) Ankylosing spondylitis
- (b) Caffey's disease
- (c) Osteomyelitis
- (d) Paget's disease
- (e) SAPHO syndrome

**59 (e)**

SAPHO syndrome (synovitis, acne, pustulosis, hyperostosis and osteitis) is a rare inflammatory bone disorder that is associated with skin manifestations. The associated hyperostosis is frequently located at the points of the bone where tendons attach, and the SCJs are the commonest site affected (70-90%). The patient is the wrong age for options (b) and (d); osteomyelitis is the main differential, but the patient is systemically well and the other features support a diagnosis of SAPHO.

- 63 An 8 year old child presents with exquisitely tender hands. Blood films demonstrate a haemolytic anaemia.**

**Which of the following are not plain film manifestations of this condition?**

- (a) H-shaped vertebrae
- (b) Rib notching
- (c) Hair on end appearance of the skull
- (d) Cortical thickening
- (e) Osteoporosis

**63 (d)**

Sickle cell disease is characterised radiologically by marrow hyperplasia. This leads to a decrease in the density of the skull with diploic widening, with widening of the medullary space. There is usually cortical thinning, along with changes related to infarction such as the 'bone-in-bone' appearance or osteonecrosis.

- 68 A 47 year old man presents with severe pain of the left shin; there is no history of trauma. On examination there is thickening and fibrosis of the overlying skin. X-rays show cortical thickening of the tibia with patchy areas of exuberant longitudinal subperiosteal bone formation and streaky endosteal new bone formation in the diaphysis and distal epiphysis. A skeletal survey reveals similar changes in the left femur, but no other abnormalities.**

**What is the likely diagnosis?**

- (a) Engelmann's disease
- (b) Melorheostosis
- (c) Osteopetrosis
- (d) Osteopoikilosis
- (e) Pyknodysostosis

**68 (b)**

Melorheostosis is thought to be caused by a gene mutation. The characteristic plain/film findings of 'candle wax dripping' is described. It tends to be monostotic, and is more common in the lower limbs with at least two bones involved. Rib, spine and skull involvement has also been reported. It can cause severe pain due to encroachment of bone onto nerves and blood vessels (which can also lead to skin fibrosis). Limb length discrepancy or contractures can result.

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**70 A 35 year old intravenous drug abuser presents complaining of pain in his great toe. On questioning, he has been using foot veins to inject drugs.**

**Which of the following statements is incorrect regarding his risk of osteomyelitis?**

- (a) *Staphylococcus aureus* is the likeliest organism
- (b) Initial plain radiographs may be normal
- (c) Localised soft tissue swelling occurs within 2 weeks
- (d) A sequestrum is not seen until at least a month after the insult
- (e) Radiographs are not sensitive detectors of osteomyelitis

**70 (a)**

*Pseudomonas* is the commonest responsible organism in drug users. *S. aureus* is the commonest responsible organism in non-diabetics. Diabetic patients typically have multiple responsible organisms. Plain films can be normal for up to 2 weeks. The earliest sign is soft tissue swelling. Other signs include osteolysis, endosteal erosion, and the formation of an involucrum, followed by a sequestrum.





